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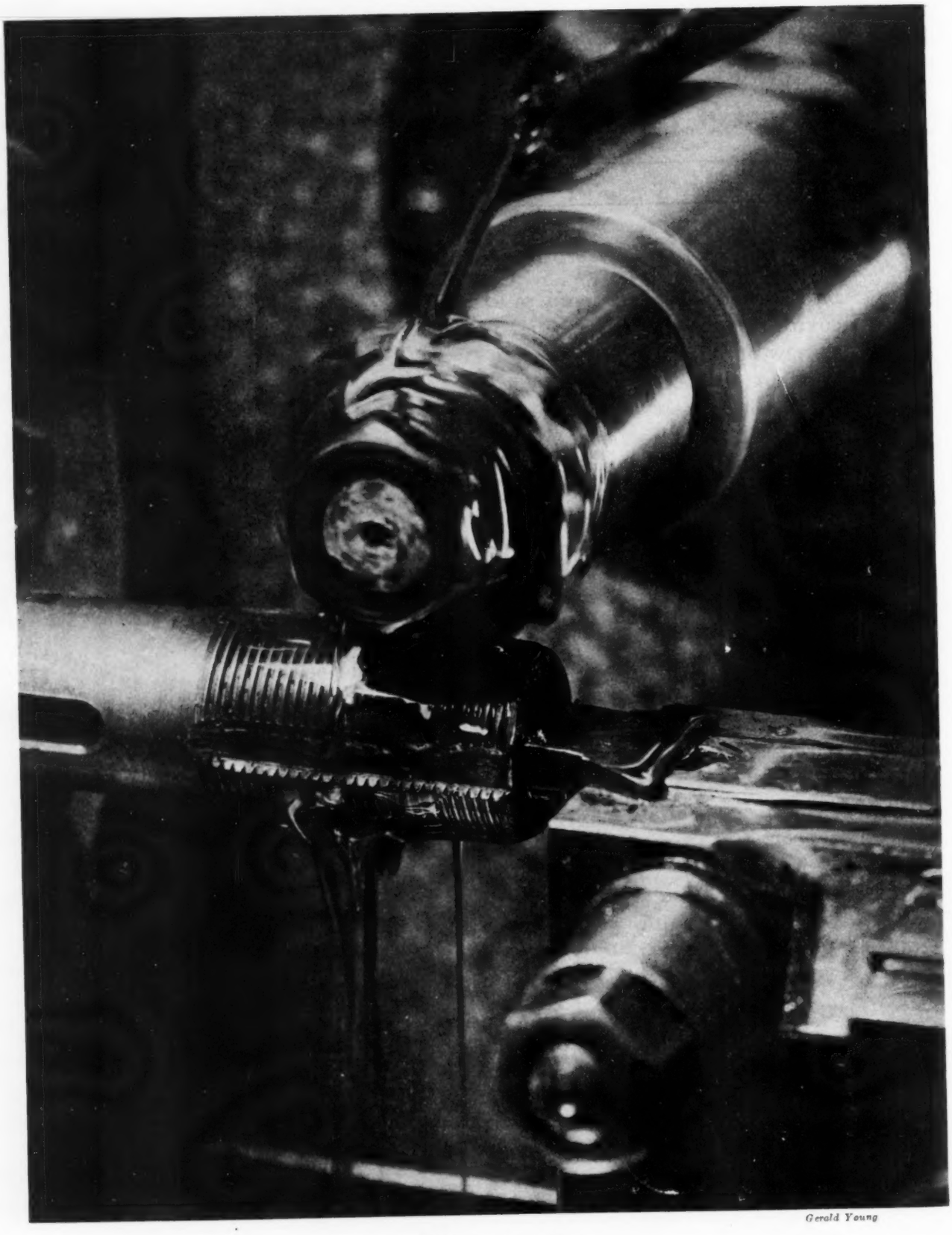


Gerald Young

Milling the Keyway

VOLUME 60
No. 2

MECHANICAL ENGINEERING

FEBRUARY
1938

GEORGE A. STETSON, *Editor*

Politicians' Day

IT WAS the politicians' day. The engineers had gone. Across Manhattan Island they were at work on the newer Queens-Midtown Tunnel, and, on the west side, on the second tube of the Lincoln Tunnel. For engineers the design and construction; for politicians the dedication and the publicity.

One's first impulse is to quarrel bad-naturedly about those who stepped into the spotlight just as the crowd got ready to applaud. But on second thought it is something to be spared being photographed trowel in hand, or at the controls of a steam shovel, or cutting a ribbon, closing a switch, or pulling a rabbit out of a hat.

Yes, it was the politicians' day, December 21, when the New Lincoln Tunnel, 8215-ft vehicular tube connecting mid-town Manhattan with Weehawken, N. J., was dedicated. The engineers had gone, but they were not quite forgotten, for Frank C. Ferguson, chairman of the Port of New York Authority, which built and owns the tunnel, spoke for the "men who built the Lincoln Tunnel . . . . whose work we celebrate today—for it is to them that this day belongs."

To name them all would be impossible, but, for the sake of the record, mention should be made of O. H. Ammann, who was chief engineer of the Port of New York Authority during most of the project, and who has recently been advanced to the position of director of engineering of the Authority; his successor, John C. Evans, formerly the terminal engineer; Ole Singstad, chief engineer, New York City Tunnel Authority; and C. S. Gleim, engineer of construction, and Ralph Smillie, engineer of design, Port of New York Authority. Upon these men and their associates rested the heavy responsibility of planning and constructing the tunnel itself and its innumerable details. Behind them the accumulated experience in methods and materials, from Brunel, who drove the first successful tunnel under the Thames, to the present, provided the background for their genius and for the confidence they and the public held from the start in the ultimate success of a great venture. Hundreds of engineers took up, as conditions demanded, such portions of the work as came within their authority, from drafting board and specification to final inspection and approval of each element and the coordinated whole. With them worked manufacturers and artisans in shops in various parts of the country, and on the site, all integrated by the engineering organization to produce the final desired result.

Honor to them, therefore, from sandhog to chief engineer, whose lives went into the great work. For long after the politicians are dead and forgotten men will use the tunnel to which no engineer's name is attached, and whose builders were so thoughtlessly elbowed aside on December 21. For in the words of Kipling:

They say to the mountains, "Be ye removèd." They say to the lesser floods "Be dry."
Under their rods are the rocks reprovèd—they are not afraid of that which is high.
Then do the hill-tops shake to the summit—then is the bed of the deep laid bare,
That the sons of Mary may overcome it, pleasantly sleeping unaware.

Posthumous Advice

FROM the other side of the globe and from the pen of a man, recently deceased, who had expected to present it in person, came by wireless to the *New York Times* Lord Rutherford's posthumous advice to the people of India that they devote their energies to scientific research in the field of agriculture. As universal as science itself was the truth Lord Rutherford expressed that "if India is determined to do all she can to raise standards of life and health of her peoples and hold her own in the markets of the world, more and more use must be made of the help science can give."

The opening of the silver-jubilee session of the Indian Science Congress at Calcutta on January 3 was the occasion of Lord Rutherford's last address, delivered for him by Sir James Jeans, with whom a hundred members of the British Association for the Advancement of Science had journeyed to the Orient.

In the flood of thoughts and speculations released by the dispatch a few persist. There is the concrete evidence, for example, that at least some members of the British Association take seriously the idea of international cooperation in science. There is the contrast of the imperialism of science and the imperialism of force and political domination and exploitation. There is the vista opened up by the possibility, offered later in the meeting by Prof. Edward Charles Cyril Baly, of the University of Liverpool, of imitating nature's fundamental process by which plants utilize sunlight in making starches and sugars from the water vapor and carbon dioxide in the air. There is the demonstration that science itself is making use, in the rapid dissemination of its most recent discoveries, of its powerful toy, the radio, perverted so frequently to the suppression of truth and the propagation of falsehood, a two-edged

sword as democracies are beginning to learn. And there is the very practical suggestion by the late scientist that men turn for help in their agricultural problems to the methods of scientific research.

If we must have subsidies, let there be subsidies for scientific research, and let us use them gainfully as the basis of new industries that will offer to idle workers and subsistence farmers new outlets for their labors.

Salute to Applied Mechanics

IN HIS address at Indianapolis as retiring chairman of Section M, of the American Association for the Advancement of Science, the text of which is to be found on pages 147 to 150 of this issue, W. E. Wickenden called attention to the difference in rate of growth of such early technological marvels as the steam engine, developed largely by craftsmen with an instinctive sense of physical forces and design, and the radio on whose behalf the rich resources of theoretical and applied sciences were brought to bear. Certainly, Watt and his contemporaries, remarkable as their genius was, would have made even more spectacular contributions to the industrial age if there had existed more thorough knowledge of the mechanics of forces and materials. Certainly today a development of similar significance would be more rapidly advanced to a position of real usefulness because of the powerful and versatile tools of design that our knowledge of applied mechanics provides. Development of this important field of knowledge is one of the first responsibilities of the engineering profession. It is not too much to say that the richness of the literature on this subject may be used as a measure of the progress mechanical engineers, at least, are making in pushing forward that sector of the frontier of industrial progress along which the entire front of material civilization advances. To the efforts and accomplishments of the Applied Mechanics Division of The American Society of Mechanical Engineers heartiest approval and appreciation are therefore due.

But the field of mechanics is broader than those areas of it in which members of the A.S.M.E. labor. It extends throughout the civilized world. Significant, therefore, is any international cooperation toward the pooling and development of this great body of knowledge such as will be made effective in the Fifth International Congress of Applied Mechanics, to be held at Harvard University and the Massachusetts Institute of Technology, Sept. 12 to 16, 1939, in which the Applied Mechanics Division of the A.S.M.E will participate.

President of the Congress is Karl T. Compton, its joint secretaries are J. C. Hunsaker, and Th. von Kármán, and the chairman of the Cambridge committee is H. M. Westergaard, all of whom are distinguished members of the A.S.M.E.

The work of the Congress will be accomplished by means of sessions at which communications from members will be read and discussed. In addition, general lectures will be delivered by scientists of international reputation. The three major divisions of applied mechanics, to which the Congress will devote its attention are: (1) Structures, elasticity, plasticity, fatigue, strength theory, and crystal structure; (2) hydro and aerodynamics, gas dynamics, hydraulics, meteorology, water waves, and heat transmission; and (3) dynamics of solids, vibration and sound, friction and lubrication, and wear and seizure. Following the week in Cambridge, Congress members are to be invited to visit the National Bureau of Standards, in Washington, and the N.A.C.A. laboratories at Langley Field, Va.

Certainly no mechanical engineer, no matter how far removed the daily circuit of his routine may be from these subjects, can fail to appreciate the importance of this branch of knowledge to technological progress, or to applaud the spirit present in this international pooling of man's most recent acquisitions of knowledge in the field of applied mechanics.

Section M, A.A.A.S

HOW many engineers who read the newspaper accounts of the Indianapolis Meeting of the American Association for the Advancement of Science, held during the Christmas holidays, realized that Section M of the Association is devoted to engineering and that the section committee is composed of representatives of engineering societies? Undoubtedly, the number is relatively small, for the attendance of engineers at Indianapolis was pitifully meager and few of those present had ever been at any other of the section's meetings.

Many reasons can be advanced for the apparent lack of interest of engineers in the A.A.A.S., but this is no place to bring them up, nor is it the place to do more than to suggest that engineers examine the situation with a view to deciding whether or not greater interest and support are worth-while. Here opinions will differ. Before a snap judgment is reached, however, the reader is urged to look over the account of the Indianapolis meeting, and the comment on it, on page 156 of this issue and ask himself if the engineer can afford to stand aloof from a movement that hopefully attacks the task of upholding intellectual freedom and proposes to work for a better understanding of science and technology by a confused world.

Admittedly, performance was more wishful than concrete at Indianapolis, but the officers of the Association are undoubtedly sincere in organizing a program of broad usefulness on the part of men of science in furthering the laudable objectives set forth in the resolution unanimously adopted by the Council and quoted in our story of the meeting. A year ago the American Engineering Council proposed a closer cooperation between engineers and the social and economic scientists. Hearty endorsement of this proposal should lead to the encouragement of any intelligent nonpartisan group effort to make effective the massed opinion and leadership of men of scientific and engineering training on behalf of truth for the benefits of the world at large.

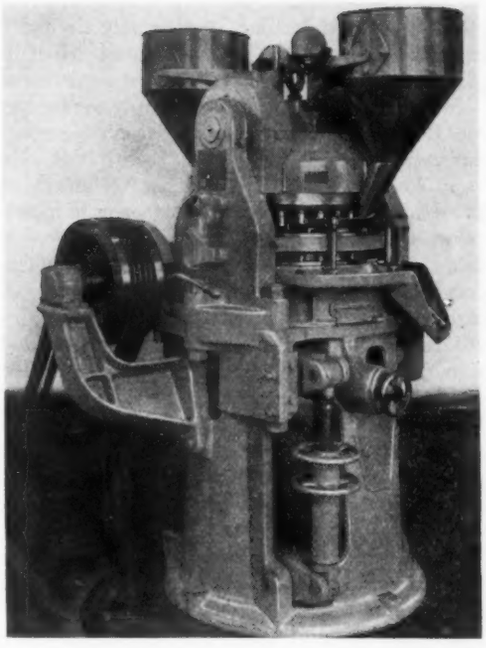


FIG. 1 IMPROVED ROTARY PREFORMING MACHINE
(Using two loading stations that are located 180 deg apart, this machine will produce between 600 and 700 tablets $1^1/_4$ in. in diameter in 1 minute.)

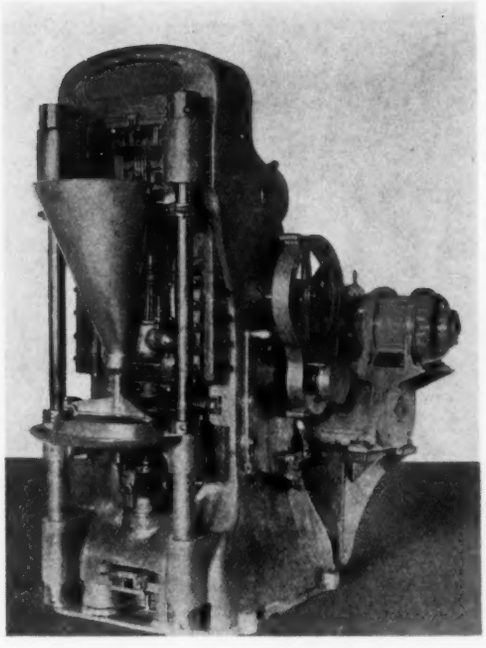


FIG. 2 AN 80-TON PREFORMING MACHINE
(A single-punch machine of the toggle type. With a 4-in. depth of fill, the capacity of this machine is from 15 to 30 tablets 4 in. in diameter in 1 minute.)

Developments in
PLASTICS-MOLDING EQUIPMENT

By LOUIS F. RAHM

SCHOOL OF ENGINEERING, PRINCETON UNIVERSITY

DEVELOPMENTS in equipment have proceeded at a rapid pace in the last few years and, although chiefly applied along two different lines, have culminated in the common objective of a fully automatic molding machine. The injection machine, required by the advent of recently developed thermoplastics, almost immediately applied this method of operation. On the other hand, the compression molding machine, while gradually acquiring improvements essential to the change, has lagged in this development and is only now being introduced as a completely self-contained automatic unit. To cover the equipment briefly but as thoroughly as possible, it is considered under the several groups as preforming equipment, molds, and hydraulic and mechanical presses.

SPHERICAL PREFORMS SUPERSEDED BY LARGE-DIAMETER TABLETS

In preforming material for compression molding, a noticeable trend has been apparent toward the disk or tablet type of preform in preference to the spherical pill that is sometimes used. Although in the process of crushing and becoming plastic in the mold, the pill traps less gas and otherwise offers some advantages in loading, these advantages have been offset by the chipping of the concave punches required to produce them. This shape of preform would appear to be the logical choice for an automatic compression machine using preformed material, but, pending further development, it will continue to find little favor in general.

In response to a demand for larger preforms, the familiar equipment has been increased in size, and a new type of preforming machine has been developed to care for work beyond this range. Thus, while the old single-punch machines remain as before, the rotary machines have been increased in capacity. By applying two loading stations 180 deg apart, the machine shown in Fig. 1 will produce tablets $1^1/_4$ in. in diameter at the rate of from 600 to 700 per minute. An increased size of rotary machine, producing 125 to 150 tablets $2^1/_2$ in. in diameter per minute, probably represents the limit of size in this type of machine. Beyond this, new single-punch machines are now available employing a toggle mechanism rather than the cam action of the small single-punch machines. One of these machines which is illustrated in Fig. 2, with a 4-in. depth of fill can produce 4-in. tablets at the rate of 15 per minute. A still larger machine of the same general type has a capacity of 25 to 30 tablets per minute, producing $4^1/_2$-in. tablets with $3^3/_4$-in. fill

Contributed by the Machine Shop Practice Division and presented at the Annual Meeting, New York, N. Y., Dec. 6–10, 1937, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

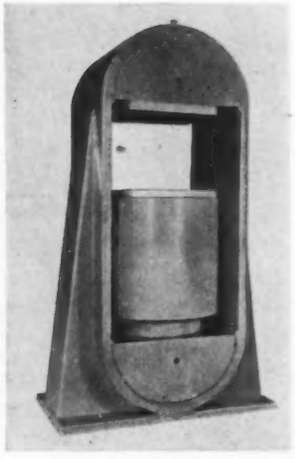


FIG. 3 BUTT-WELDED LINK-TYPE PRESS FRAME

and compressing from both sides.

Formerly, the need for such preforms was met either by using several small tablets to charge the die or by the slow process of producing large tablets in a hydraulic press. Requiring less bulk for a given weight of material than an aggregation of small tablets, these disks permit easier loading, with less risk of spilling when crushed in the mold, and eliminate the possibility of striations in the molded piece which are sometimes produced by several small tablets.

Operation of preforming machines has been materially improved through the use of variable-speed transmissions. Variations in tableting properties of various materials, or different batches of the same material, may be compensated for by only slight adjustment of the speed, which was not possible previously. This permits using rotary machines where, formerly, troublesome material would require working on a single-punch machine.

ALLOY STEELS NOW PREFERRED FOR MOLDS

From the viewpoint of materials, molds show some definite changes. Whereas in the past, pack-hardened low-carbon steel was considered standard material for dies and is still used to a great extent, the preference for chrome-nickel steel is increasing at present. For this application, alloys which are produced either by machining or the special process of hobbing are available for dies. In general, these steels have a more uniform grain structure than the older materials, thus reducing risk of spoilage in making the dies and, of even greater importance, is the longer life of dies resulting from greater resistance to wear.

Dies made of high-carbon tool steel, while satisfactory for continued heating, eventually develop a maze of fine surface cracks under alternate heating and chilling. This condition, which is progressive, makes such dies unsuitable for use even though abrasive wear may be negligible. While only the most exacting type of compression molding requires heating and chilling of molds, the new mold steels are a distinct improvement in this particular work.

Chromium plating of dies was expected to be widely adopted, but this development has had little growth. At present, such plating is not common and, in many cases, is done to resize worn or oversized dies, rather than as a matter of finish. Since the finish in general is never better than the surface on which it is placed, this offers no short cut in polishing dies and, hence, appears to have no obvious advantage. On long-run molding, however, plated dies have shown unusually good wearing qualities, and, as evidence that their surface does differ from that of the plain polished die, indiscriminate sticking of moldings in the mold can sometimes be avoided by plating either all upper or lower dies to make the pieces remain with the unplated set until ejected.

Cast-metal molds of a copper-beryllium alloy have been proposed and have been tried with limited success. While this material in itself has desirable properties for molds, the lack of sharp definition of pattern in casting and accuracy in dimensions precludes its use in cast form for precision molding, although it can be applied to the production of art or novelty goods. Since this alloy is extremely difficult to hob, being suitable in some cases for making hobs, it is unlikely to supplant the more common steel used for accurate molds.

Introduction of injection molding was expected to reduce mold costs through the possibility of using soft steel for dies, but experience has shown that such molds, while usable even as in compression molding, do not retain their surface finish. In addition, and owing to displacement of metal around the die cavities, fins of progressive thickness occur on the molded parts in a short time, increasing finishing costs. Thus, for work of comparable accuracy, injection and compression molds will be made essentially of the same materials.

Little change has occurred in recent years in basic mold design, but more progressive designs of earlier vintage have yielded a return in lower mold costs. This was derived chiefly in the field of high-production molds from repeated use of standardized heater plates for mounting new dies, with original accessories and fixtures being retained so far as possible. The injection-molding field has been changing too rapidly to take advantage of this mold-chassis principle, and, as a consequence, injection molds cost relatively more per cavity than compression molds of equal capacity, although total cost is much less.

Design of injection molds is basically that of the flash type used in compression molding. One minor change is the omission of the flash or cut-off surface since the mold is closed when empty. However, in spite of the high locking pressures used to keep the mold closed during injection, it has been found advisable to relieve a large proportion of the flat mating surfaces by grinding. In leaving a land of sufficient area around the cavities, perhaps 0.500 in. wide and from 0.005 to 0.010 in. high, to sustain the initial load, proper die contact is practically assured. A second and more-important feature in injection-mold design concerns the inlet port in which the main stalk or gate is formed and the channels forming the sprues. Experience, rule of thumb, and trial and error share about equally in this detail of design since the great variation in requirements permits no rational or standard approach to the problem.

Making dies by machining has been facilitated by wider use of automatic die-cutting machines operating on the pantograph principle. These are particularly desirable for medium and large work where duplication of dies in small quantity may not otherwise be feasible. Smaller machines, called duplicators, are proving equally desirable for the great bulk of small die work within their range, and, of course, both machines are well-suited to the machining of hobs.

While hobbing in itself has shown no

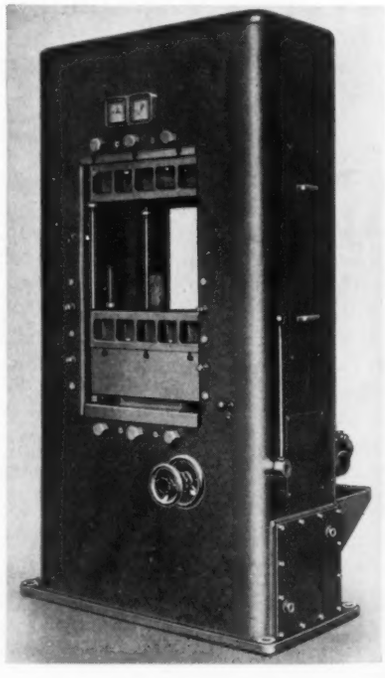


FIG. 4 A 100-TON SEMIAUTOMATIC PRESS HAVING A SMOOTH FRAME OF WELDED STEEL PLATE WHICH COMPLETELY ENCLOSES THE MACHINE

new developments, these machines have simplified preparation of die blanks for the hobbing process when the hob is to be started in a prepared cavity, or when the backs of the blanks are to be relieved. For hob material, high-carbon tool steel is being increasingly displaced by chrome-molybdenum steel.

HYDRAULIC PRESSES GENERALLY UTILIZE RODLESS CONSTRUCTION

Little or no change has taken place in the simple cored-platen press as such, yet the old principle of rodless construction, originated by Burroughs, is now recurring in various new presses. This change has produced (*a*) cast-steel side frames in place of rods, (*b*) steel plate as similar side members, and (*c*) a continuous and link-shaped frame of welded steel plate (Fig. 3) in which the cylinder and platens are mounted.

As applied to presses in general, any of these methods results in a more compact unit, with the cast-steel side frames still providing the usual degree of accessibility from the sides. Steel-plate construction in one form (Fig. 4) affords convenient opportunity for neat mounting of gages and indicators and concealment of less sightly accessories and controls and, on the whole, is an agreeable innovation in general appearance.

Another development that is applied to presses in general is chromium plating of the rams to avoid scoring and to prolong the life of packings. This has even been extended to the reconditioning of badly worn machines where restoring nominal diameter of the ram by copper plating may be necessary before applying the final surface.

Among the common sizes of semiautomatic presses many are now offered with automatic press-cycle control and self-contained oil-pumping units. Pumps used either have a variable delivery or are a combination of high- and low-pressure constant-discharge pumps. As such presses are usually served by a central steam supply, they cannot be considered completely self-contained units but may be readily made so through use of individual steam generators or electrically heated molds. The higher operating cost of such independent units can be justified by their convenience for overtime or partial operation of the plant. Semiautomatic presses with inverted or overhead cylinders are available in new designs, but a strong preference is shown for the more conventional style with movable lower platen. In response to the demand for larger equipment, this type of press is now commonly built in capacities of 400 and 500 tons (Fig. 5), occasionally larger, and, at least in one case, of 1500 tons. These large machines are seldom, if ever, self-contained. When compared in size with the numerous 75- to 150-ton presses that have been used for years, they indicate definitely one major trend in the equipment field.

FIG. 5 A 500-TON SEMIAUTOMATIC MOLDING PRESS OF RODLESS CONSTRUCTION

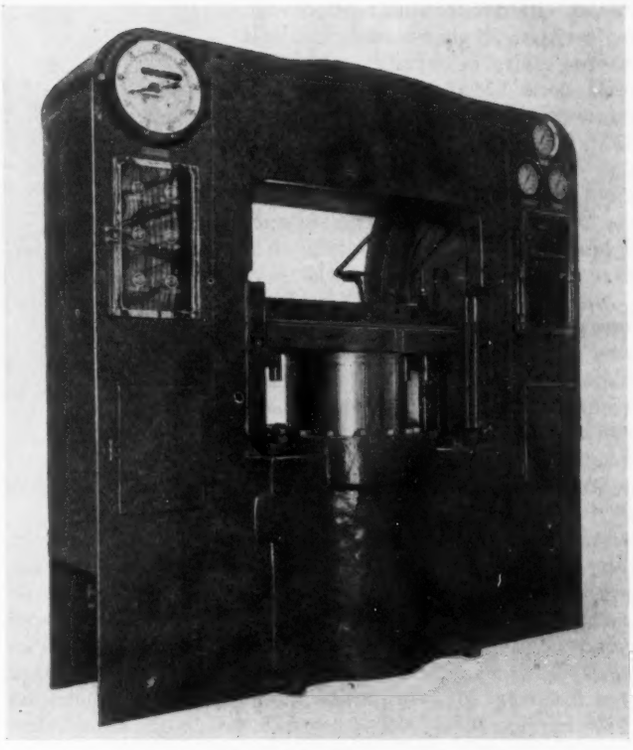


FIG. 6 A 330-TON TILTING-HEAD PRESS

(This machine is another example of the use of steel plate for the main tension members. It is equipped with a self-contained pumping unit and automatic press-cycle control.)

Several new-style tilting-head presses have been developed, each using a slightly different principle of operation to tilt the dies and, in some cases, being essentially tilting-die presses with fixed head. While the original tilting-head press was usually built in a 75-ton size, several of these new machines are of 330 tons capacity (Fig. 6) and in one case 1000 tons. Again may be noted the use of steel plate for main tension members and the application of automatic cycle control and self-contained pumping units.

The angle-molding press continues its unique position as the most special in type, usually being designed for a specific job. In one recent design in addition to the usual vertical overhead and horizontal cylinders, a third ram that works vertically upward has been installed to operate a particular split mold. In spite of the ill favor in which it is usually held, this type of press still remains the proper unit for the occasional odd molding job in its field.

PRODUCTION COSTS REDUCED BY HYDRAULIC INJECTION MACHINES

Most of the present interest in press equipment centers around the injection machines that have been developed to handle thermoplastic materials. While, in most cases, these materials could be molded equally well by compression machines, the relative cost of heating and chilling such molds would be prohibitive for ordinary work, and, in addition, the boiler capacity of most plants developed on hot molding would be entirely inadequate for such demands.

Entirely apart from this consideration is the fact that, for equal production, injection molds are considerably cheaper than compression. For example, a 120-cavity compression mold may require a 4-min cycle for such work owing to heating and chilling, whereas an injection mold operated three times per

minute will have the same capacity with ten cavities. If the assumed die cost is $20 per cavity in either case, the first mold costs $2400 plus perhaps $200 for assembly. The injection mold at $200 for dies and $200 for assembly thus becomes a nominal expense, although much higher per cavity than the other. This latter feature, in spite of low total mold cost, has been hard to accept by beginners in this field.

Injection machines first introduced were entirely or essentially mechanical, but those developed since in the United States are basically hydraulic. An early mechanical injection machine of German construction is illustrated in Fig. 7, while Fig. 8 shows a hydraulic injection machine that has been developed in the United States. As regards increasing sizes, which in the first place warranted the hydraulic unit, these machines are still in a state of rapid growth. The first $1/2$- and 1-oz machines were soon superseded by domestic machines of 2 to 4 oz capacity, until at present with larger sizes in demand one machine is capable of 6 oz per cycle, heating 50 lb of material per hour, and provides for 40 sq in. of injection area. Many of the new machines will prove adequate in size for most work, although still larger units will doubtless be built. In all cases these machines offer the great convenience of being self-contained and in having an electrically heated material cylinder and independent pumping unit, in addition to a system of controls making possible automatic, semiautomatic, or manual operation.

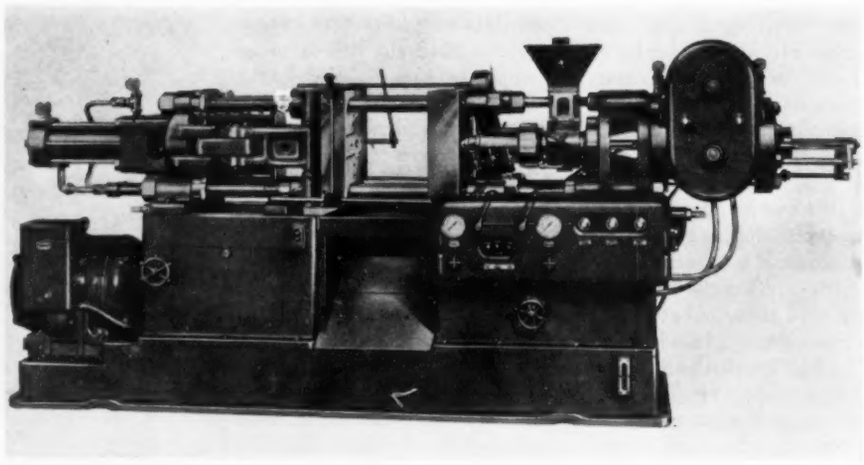


FIG. 8 HYDRAULIC MACHINE FOR INJECTION MOLDING OF 3-OZ PIECES

Development of the injection end of the new machines shows adoption of alloy steel for the injection cylinder as well as the ram, and, in some cases, both these parts are chromium plated to reduce wear. Pressure required to move the material varies widely between different plastics and even between different temperatures in the same material, but reaches the maximum of 28,000 to 30,000 lb per sq in. on the face of the ram and explains the necessity of careful selection of cylinder material. While, in all cases, the ram is hydraulically operated, the oil-pumping unit is readily adjusted to the varying pressure requirements of different plastics, and the ram is withdrawn after each injection to permit the addition of an equal weight of new material to the heating cylinder. Heating of the plastic can be controlled to suit various materials and different rates of injection.

Details of cylinder design vary to such a degree that, in some cases, purchasers of machines have attempted their own improvements of the cylinder core. Incidentally, a core, as employed by Hyatt in his early machine for pyroxylin some sixty years ago, was recognized then as a necessity and commonly referred to as "the pineapple." The function of the core is to reduce the cross section of material to a relatively thin layer where it passes the main heating surface, and also, if possible, to contribute to the heating. In only one or two cases, has any effort been made to heat the core other than by the doubtful contact with the warm cylinder. Since, by thus increasing the heating surface, material could be moved at lower pressure and heated with less risk of burning, on account of lower wall temperatures, this detail may be expected to receive further consideration notwithstanding difficulties of design. To prevent plasticity of the material on the face of the ram, the loading end of the cylinder may be water cooled, while, to prevent undue chilling at the nozzle, additional heating units may be located in the nozzle holder. The necessity for the latter was also recognized by Hyatt in his early designs and a steam jacket was applied there.

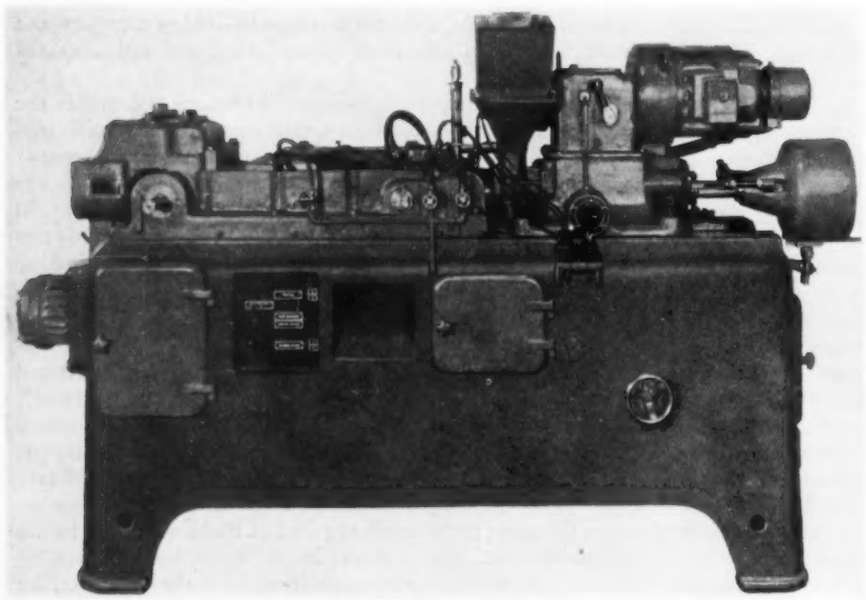


FIG. 7 AUTOMATIC MECHANICAL INJECTION-MOLDING MACHINE

(This machine, which is a German forerunner of larger domestic machines, produces pieces weighing $1\frac{1}{2}$ oz.)

The other end of the injection machine shows some variation in details concerned with the operation of the movable die plate. This must move rapidly in opening and closing the mold and is actuated in some cases directly by a hydraulic cylinder and in others by hydraulically operated toggle mecha-

nism. In either case the total load on the mold must be sustained by this locking device without permitting the dies to separate even to the extent of the slight strain in the main rods. The load may be as much as 85 per cent of the theoretical hydrostatic load on the plastic, and somewhat less if the material is in a less plastic state.

The fixed die plate is movable to the extent of breaking contact with the injection nozzle after each injection to avoid chilling the material left in the nozzle. In some cases, it can be moved a considerable distance from the nozzle for purposes of inspection. The nozzles themselves are not standard in tip form, both flat and spherical tips proving satisfactory.

Thus far, progress in injection machines has developed the horizontal unit as the most convenient type for the ejection of work. With the present interest in extending the process to moldings requiring inserts or cores, already some demand has arisen for vertical machines. Such machines are expected to be available soon and the saving in floor space should be appreciable. Fig. 9, although a horizontal machine, illustrates the economy in floor space through use of a vertical material cylinder.

Corresponding to the curing of thermoplastics in compression molding, the natural limitation in the injection process is the chilling time of the material. Molds must be cooled at a temperature above the dew point to avoid vapor condensation upon opening, otherwise the surface of the molding will be spoiled. Depending upon the size and shape of the piece, a still higher temperature may be required to avoid premature chilling of the plastic before the mold is filled. As a consequence of these limitations, the material should be injected as quickly as possible, and the molded piece should be designed for minimum thickness of sections.

TRANSFER MOLDING APPLIED TO THERMOSETTING MATERIALS

Closely related to the injection process is the transfer method of molding, which differs chiefly in being applied to thermosetting materials and requires less elaborate equipment. While patents covering method and equipment are of relatively recent date, transfer molding has been used for some years in the production of delicate and difficult moldings, especially where thin-wall sections or slender mold pins are involved. Equipment used for this process has evolved gradually from the semiautomatic press and, in final form, may be considered a vertical injection machine in which the overhead material chamber is loaded for each cycle with a slight excess of material.

Upon sufficient softening from the heated plunger and pot, the material is forced downward into the adjacent hot mold where it is held until cured. The cull of excess material which hardens in the pot is readily removed and, although waste, represents an insignificant loss. The heating chamber is essentially simpler than that in the injection machine, and further, the operation can be stopped at any time without disrupting the normal cycle, since no material is stored in this chamber. Although a natural limitation is imposed by curing time of the molding material, the total time that the material is in the mold is considerably less than in compression molding. For large molds, it has been found relatively simple to provide multiple nozzles directly serving the several small dies or a single large cavity. Since the process is particularly well-suited to intricate moldings that may require the setting of inserts or cores, full-automatic operation of equipment has been considered of little importance but can be applied as readily as in the case of injection machines.

The equipment, although developed for molding thermosetting materials, can be applied to thermoplastics where this particular method may be desirable as in injection molding, but the natural cycle for this work is longer than that of the injection machine. Since ordinary compression molds can readily be altered to suit this process and many complicated compression-molding problems are eliminated at the outset by transfer molding, this method of molding may be expected to find wider use in the future.

AUTOMATIC MECHANICAL PRESSES FOR COMPRESSION MOLDING

Mechanically operated molding presses have never been widely adopted by the industry although some few installations have been in operation for a considerable time. In addition to a relatively low purchase price, power requirements for operating such presses are less than in other types. The mechanical press, being particularly well-suited to individual operation, represents the first standardized self-contained unit with push-button control, although such features had been infrequently applied previously to hydraulic presses built on order. Completely mechanical units are available for compression molding, as well as a newer intermediate style in which a toggle mechanism is augmented by a hydraulic ram in an effort to establish the proper mold pressure more exactly.

Among injection machines may be found an even more striking example of completely independent units from which ideas have been borrowed in hydraulic applications. The German machines that were imported when no domestic machines were available soon proved inadequate in capacity, and much of the breakage in such machines can be accounted for by the tendency to use them at and beyond their extreme limit. On later machines, the electrical control systems gave some trouble in being insufficiently rugged for the purpose and so complicated as to make servicing difficult. In spite of such shortcomings as may have served as object lessons for American design, many of these machines are giving satisfactory service where nominal

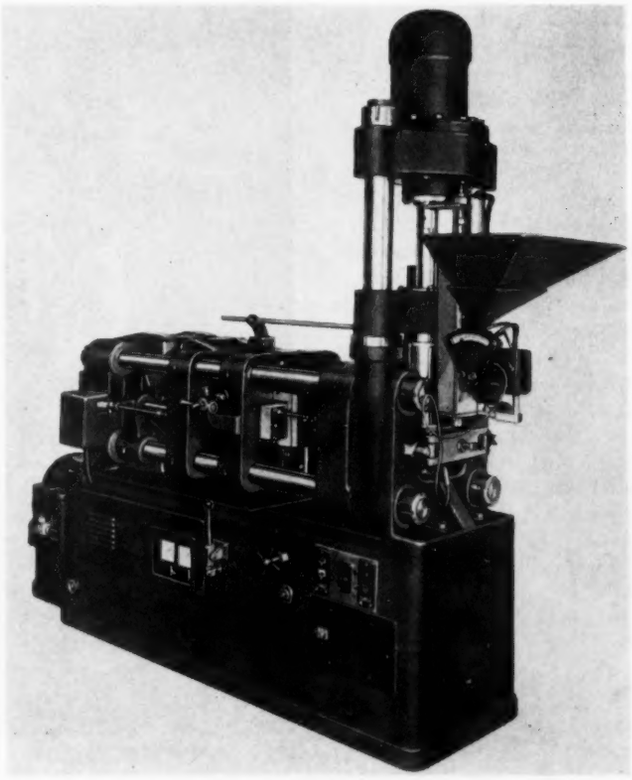


FIG. 9 HYDRAULIC INJECTION UNIT THAT CONSERVES FLOOR SPACE BY USING A VERTICAL MATERIAL CYLINDER AND RAM

capacity is required. In deference to an obviously progressive idea, these machines may well be acknowledged as an achievement in clever basic design and could probably show superior performance in comparison with machines of similar capacity, with no more than minor changes in detail. They are, however, losing ground owing to the demand for larger machines which makes the hydraulic unit preferable and the development of domestic designs of the latter to supply this market.

Most recently, attention has turned to compression molding in an effort to apply completely automatic control to this process. Since automatic press control is provided in many of the new semiautomatic presses, a logical step would be to provide an automatic loading and unloading device to attain the desired end in presses of nominal size. On occasion, this has been done in large-volume molding of a standardized product, but the great expense involved has inhibited development of such a press for general use. Actually the approach to the problem has been along a different line, and the resulting automatic press makes its entry into relatively small job-molding work rather than the high-production field.

This new mechanical unit, which is illustrated in Fig. 10, is of relatively small size, but may attain a large daily output for its size by continuous 24-hr operation. An easily adjusted and relatively simple system of automatic control serves as the basis for its operation with sufficient latitude in regulation to accommodate various thermosetting materials. Bulk molding material from an overhead hopper is automatically measured and fed to the mold by gravity, after which the mold closes for a predetermined time to form the molding, opening once in the process to gas the mold if desired. The piece is then lifted from the bottom die by ejector pins and removed from the mold by compressed air. Any interference with the established cycle, which might result from a piece remaining in the mold, causes complete interruption through the controls and signals for attention.

In having the mold close against the reaction of a pair of heavy coil springs, convenient opportunity is afforded for closing at a predetermined pressure by stopping the motor at this point. As a result of running the motor only when needed, operating costs are low. Bulk material could be handled equally well by the present feeding mechanism for charging a subcavity mold for multiple moldings, and, with a change of mechanism, the machine could operate with preformed material in a flash mold.

This machine is intended for simple moldings in lots of perhaps 25,000 maximum, and, although not suited to produce intricate shapes requiring special mold features, it still covers a great range of small job-molding requirements. Adequate data upon its reliability for continuous operation, as well as its cost of operation, have been compiled during its semicommercial phase. Its claims to economic consideration are based on the simple premise of an inexpensive mold operated continuously. Using a single-cavity mold for 24 hr per day, production is comparable to that of an operator using a three-cavity mold on an 8-hr basis. However, in the latter case, mold cost is considerably more, and added wages make the cost per piece appreciably higher than in the automatic machine. On this basis alone, the present machine warrants the attention of custom molders and an interest in the further development of larger machines for similar work.

The author wishes to acknowledge with thanks the illustrative material furnished by several companies and the assistance of numerous individuals who have contributed in various ways to the preparation of this paper.

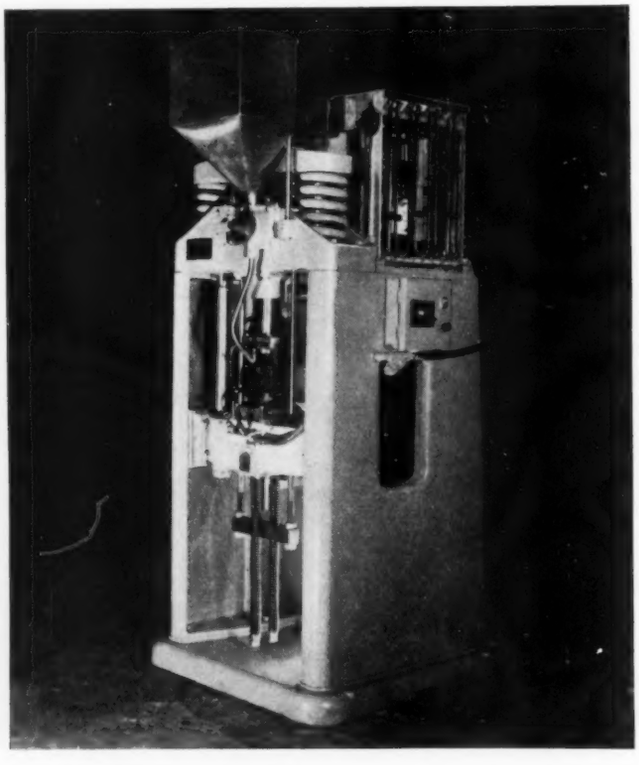


FIG. 10 AUTOMATIC COMPRESSION-MOLDING MACHINE

(Although relatively small in size, a large daily output can be obtained by operating the machine continuously for 24 hr. Bulk powdered material is formed into simple moldings, and, while the machine is not suited to produce intricate shapes requiring special mold features, a great range of small job-molding requirements can be covered.)

COTTON SPINDLEAGE *in* THE UNITED STATES

Some Comments on Its Growth and the Future

By A. W. BENOIT

CHAS. T. MAIN, INC., BOSTON, MASS.

COTTON manufacturing is one of the oldest of our basic industries and it has had an honorable, if somewhat stormy, career. It had its beginnings in the United States when little or no power-driven machinery was available and struggled through various stages of development to a highly mechanized and standardized industry of enormous proportions. Connected with it, in this development, have been men of ability as organizers of labor, foresight, and genius in its mechanical advance and merchandisers of high merit in disposing of its product.

From 1880 to 1900, the number of spindles increased from 10 to 20 millions. By 1920, the 20 million became 36 million, and, in 1925, the maximum of about 38 million spindles was reached. Between 1900 and 1925, about 720,000 spindles per year were added, on the average, to the cotton mills of this country. In this period not a single year passed without a substantial increase and with no indication that the growth was not to continue more or less indefinitely.

Then, in 1925, a curious thing happened. The number of spindles in place decreased by nearly one half a million. Next year, the recession was about a million, and, from then until now, the liquidation has continued. Last reports show less than 28 million spindles in place, a decrease of 10 million in 11 years, or almost one million per year, or 25 per cent, a catastrophe unparalleled in our industrial world.

That this picture may be visualized, I have prepared a graph (Fig. 1) showing a century of development in the cotton industry, using the number of spindles in place as the indicator. Fortunately, many data relative to the cotton industry have been compiled, some by private individuals and many by government agencies, particularly the Department of Commerce. From this information, we are able to chart the course of almost every phase of its many ramifications, watch trends and forecast probable events. This information is largely in the form of statistics, but when it is plotted in the form of a chart or graph we get rather startling and illuminating results.

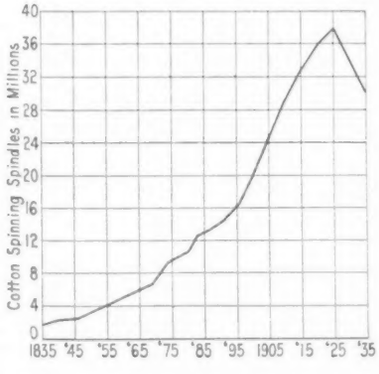


FIG. 1 COTTON-SPINNING SPINDLES IN PLACE IN THE UNITED STATES BETWEEN 1835 AND 1935

Presented at a meeting of the Textile Division, Boston, Mass., Oct. 15, 1937, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

DATA ON SPINDLES IN PLACE DO NOT PRESENT TRUE PICTURE

Bare figures of the number of spindles in place give one only a meager description of the true situation. This industry had its infancy in New England and there grew up into lusty manhood. Meanwhile, before the Civil War, a beginning was made in the South, but, for many reasons, its growth was slow and some time elapsed before it obtained a real foothold in its competition with New England. In 1905, about 7 million spindles were operating south of the Mason and Dixon line and twice as many in New England. In the period of expansion extending from 1905 to 1925, the South grew from 7 million to over 17 million, and in the same period New England reached a peak of about 18.5 million in 1921 and then dropped back to 16 million. In 1924, the number of spindles in the North and South was about the same, or 17 million.

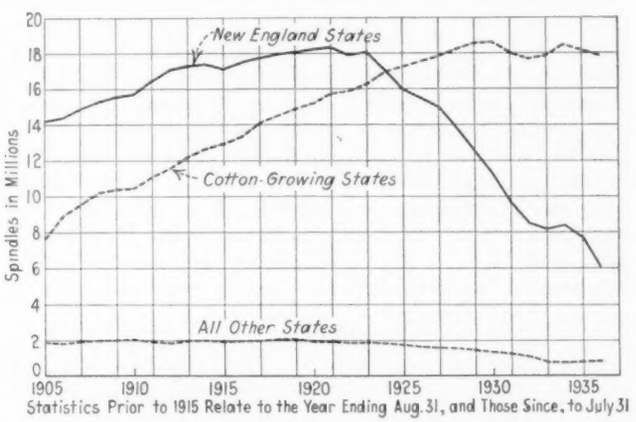


FIG. 2 ACTIVE COTTON SPINDLES FROM 1905 TO 1936

(These figures, which were compiled by the United States Department of Commerce, show how New England has lost its supremacy in the cotton-manufacturing field to the southern states.)

From 1925 to 1937, a different picture is presented. The South advanced to about 19 million spindles in place, had some ups and downs, and went into 1937 with about 18 million. The New England states reduced their spindles so fast during this period that when plotted the graph looks like a ski jump with a take-off in 1934 and then a continued descent, the bottom of which has not been reached.

In Fig. 2 is shown the relative number of spindles in place North and South year by year. These graphs have increased our view but it is still incomplete, and one feels a little perplexed and probably amazed that New England has not been able to hold its own in this struggle for supremacy in the cotton-manufacturing field.

Further light can be thrown on the subject by other data

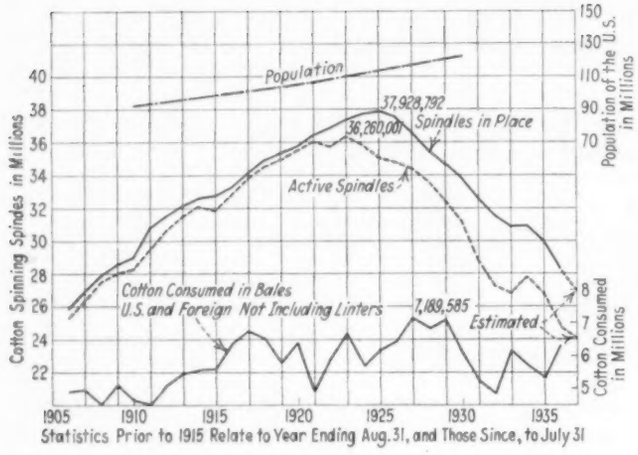


FIG. 3 DATA ON POPULATION, SPINDLES IN PLACE AND ACTIVE, AND COTTON CONSUMPTION BETWEEN 1905 AND 1936

that are available. The rise and fall of the number of spindles in place is bad enough, but the real facts are even worse. Any spindle that is still on the floor and possible of being operated is recorded as a "spindle in place." Any spindle that has been operated at any time during a month is recorded as an "active spindle." We find that, from 1905 to 1921, active spindles were from $\frac{1}{2}$ to 1 million less than those in place, which is normal, taking into consideration the seasonal changes and vagaries in styles, but, from 1921, the difference between spindles in place and active spindles ranges from 2 to 4 million. To show this comparison, Fig. 3 has been prepared.

ACTIVE SPINDLES DECREASED FASTER THAN SPINDLES IN PLACE

About 1925, when we had in place approximately 38 million spindles, of which only 35 million were active, the natural conclusion seemed to be that, if we reduced the spindles in place to 35 million, all would be well. In 1928 spindles in place were 35 million but active spindles had dropped to 32 million. The drop in active spindles was faster than the reduction of spindles in place and we have not to this day caught up with ourselves. At the end of 1936, the relative figures are 25 and 28 million.

Another feature worth noting is that although the peak of activity was in 1923, the number of spindles in place continued to increase until 1925. For the industry in general, this was a most unfortunate increase, but unhappily, hindsight is always better than foresight. On this same chart is a graph of the growth in population of the United States. The increase has been at a surprisingly uniform rate from about 90 million in 1910 to 122 million in 1930, or a little over one third. Cotton consumed per year by the mills of the United States is also shown on this same chart. This curve follows in a general way that of cotton-spindle activity but has many inexplicable ups and downs, some of which may be caused by differences in methods of reporting. For instance, in the years when approximately 6.5 million bales were consumed, the number of active spindles required to use this cotton varies from 25 to 35 million. More detailed study of this relationship might reveal the answer, but, at present, the reasons can only be surmised.

This presentation of the subject of spindle activity would not be complete unless the New England and southern groups were shown separately. This has been done in Fig. 4, and the completeness of the collapse of cotton spinning in New England becomes apparent. From a high of 16 million active spindles in 1923, New England dropped to 4 million in the hopeless days of 1932 and is now about 6 million. Feverish activity arising from the NRA Code is plainly seen.

The story in the South is markedly different. In 1930, a total of about 19 million spindles in place was reached and, to date, has continued at a little above or below this figure. Active spindles have been somewhat less proportionately in the last seven years but as a whole have held up well. On this same chart are shown the spindles in all other states, and it is apparent that their fate is of minor importance to the industry. One might say, however, just in passing, that these spindles seem to fare better than those in either New England or the South; at least they run on a more even keel.

SINGLE-SHIFT OPERATION DOES NOT PROVIDE SOLUTION

From the foregoing, the natural conclusion would be that the cotton-textile industry is overspindled for the method under which it is being operated and that further reductions must take place. The suggestion has been made that, if the entire industry were operated on a single-shift basis, no excess capacity would be found. Monthly percentages of single-shift capacity which each section operates are available, based on the normal single-shift hours of each section, and have been plotted as Fig. 5 on which the 100 per cent line is drawn heavily.

In more months, the requirements are below rather than above 100 per cent of single-shift spindle capacity, but rough computations show that it is only by a small margin. The years of 1927, 1929, and 1936 stand out as above-normal years. The low point in 1932 was only 50 per cent of single-shift capacity. To limit operation of cotton spindles to a single shift by statute would not permit them to supply the demand in good years, which must lead to further imports, and, in poor years, an appreciable percentage would have nothing to do. Since the poorer or marginal spindles would be the first to be shut down, evidently they could not be operated except in good times and so could not continue to exist.

Limiting of cotton spindles to single-shift operation by statute has been suggested as a remedy and an answer to this problem. This is an interesting suggestion and would probably divide the country into two factions in just about the way that the question of states' rights did in Civil War times. Much of the dominating part of the cotton-textile industry is in the South where all factors are arranged for double-shift and even

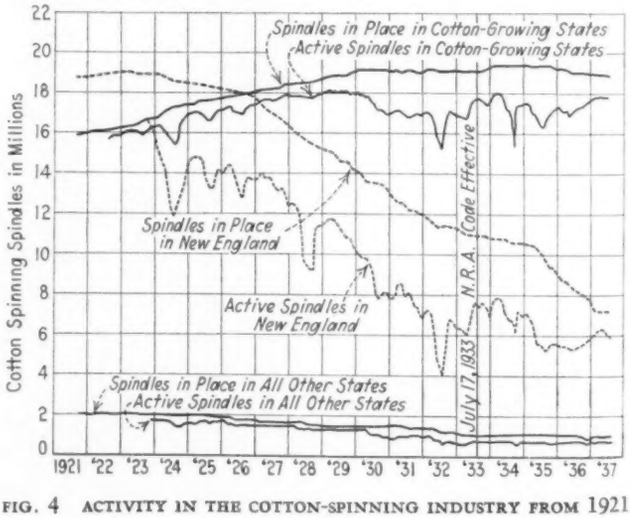

Spindles in Place in Cotton-Growing States
Active Spindles in Cotton-Growing States
Spindles in Place in New England
Active Spindles in New England
Spindles in Place in All Other States
Active Spindles in All Other States
N.R.A. Code Effective
July 17, 1933
Cotton Spinning Spindles in Millions

FIG. 4 ACTIVITY IN THE COTTON-SPINNING INDUSTRY FROM 1921 TO 1937

(This chart, which is based on Department of Commerce figures, shows the marked decline that has occurred in the spindles in New England as contrasted with the growth in the South prior to 1930 and the maintenance of an approximately constant position since.)

triple-shift operation. It is doubtful if the southern mills and mill help would take kindly to the idea of one-shift operation. No doubt single-shift operation would be best from many points of view but it is doubtful if it can be brought about.

Fig. 6 is another interesting chart along this same line, which shows the number of hours each spindle operated per month for the whole country. On it also are lines showing the hours per month for 40, 48, 55, and 80 hr of weekly operation. This chart shows again the wide fluctuation of activity in the industry. Only at rare intervals does demand exceed 55 hr per week single-shift capacity, and, with the exception of Massachusetts, legal operating hours of cotton spindles in other New England states and in the cotton-growing states are 54 and 55. At present, we are attempting to continue with the 40-hr shift set up by the NRA and because a mill cannot be operated profitably on 40 hr, two 40-hr shifts are considered necessary. A glance at the 80-hr-per-week line will indicate how utterly impossible is attainment of any such basis of operation. Granting that these charts have errors due to improper reporting of spindles or other causes, the trends are so pronounced and the evidence of such preponderance is so apparent that even though discounted for possible errors, the conclusions are inevitable.

FACTORS AFFECTING FUTURE NUMBER OF SPINDLES

Many reasons are advanced for the changes that have taken place, such as improved machinery, style changes, better operation of milis, greater seasonal swings, labor troubles, hours of operation, other competitive fibers, and reduced cotton consumption. We are primarily interested in the future and the number of cotton spindles this country can support. It is a complex problem, but some of the causes can be diagnosed and their influence evaluated, and, out of this analysis, some conclusions can be drawn.

The more obvious things affecting the future number of spindles are:

(1) Consumption of cotton
(2) Competitive fibers, such as rayon
(3) Increased production per spindle
(4) Average numbers of yarn spun
(5) Hours of operation in the mills

Government reports for cotton consumed from 1915 to 1936, inclusive, show an average 6,083,910 bales or 6,100,000 to use round figures. Fig. 3 will be of assistance in this connection. In 13 of the 21 years the average was exceeded; the maximum was 7,189,585 in 1927 and the minimum 4,866,016 in 1932. For

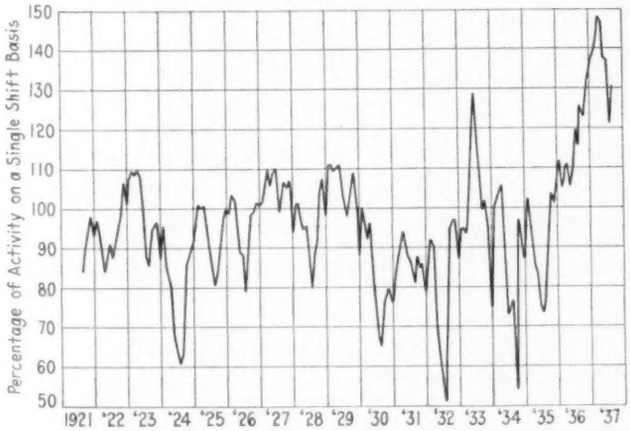


FIG. 5 PERCENTAGE OF SINGLE-SHIFT CAPACITY OPERATED BY MONTHS FROM 1921 TO 1937 FOR THE ENTIRE INDUSTRY

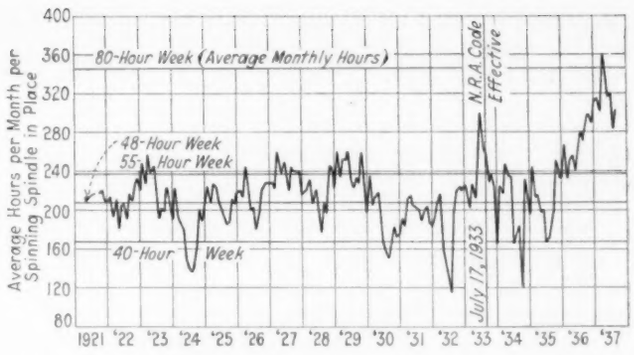


FIG. 6 HOURS OF OPERATION FOR EACH SPINDLE IN PLACE

1936, consumption was above the average, but the decrease in spindles continued, and, in 1927, with the peak production of all time, the trend was still downward. The number of bales consumed per year has some strange vagaries but rarely digresses far from the average, and, evidently no great reduction in the use of cotton has occurred as many people suppose. Neither the cause for the reduction in spindles nor the solution of the future trend can be found in a study of the cotton statistics, and the answer must be found elsewhere.

It is a common impression that the almost fantastic growth of the rayon industry is the principal reason for the difficulties of the cotton spindle. If we again use the figure just given, of 6,100,000 bales of cotton per year consumed as an average and 500 lb per bale, we get a total of 3,050,000,000 lb. Total rayon production in this country last year was 270,000,000 lb, and the estimate for 1937 is a little over 300,000,000 lb, or about 10 per cent of the total cotton crop. This will be affected by imports and exports, but only slightly. Of this total, a considerable part will go to replace silk and fibers other than cotton. Probably only about 5 per cent of the former cotton production is lost to rayon, although a pound of cotton is not necessarily equivalent to a pound of rayon, and this loss is somewhat offset by added uses of cotton in special fabrics. Cotton still is king!

I next considered the possible change in production per spindle to determine how much that has contributed to the loss in spindleage and what its future trend might be. From information obtained from various sources, I came to the conclusion that, on an average, this increase, for any particular count, might have amounted to 5 per cent in the last ten years and any change in the near future is unlikely. Obviously, this accounts for only a small part of the reduction in spindles and furnishes only a slight indication of the future.

Many believe that the average count of yarn spun has decreased, thereby increasing the average production per spindle and consequently less spindles are required. Certain data are available in government reports from which the annual average count can be determined over a period of years. The average weight per bale for 11 years up to 1935 was 506 lb, and, applying this to the 1935 cotton consumption of 5,369,867 bales, we get $2^{3}/_{4}$ billion pounds. Spindle-hours run in 1935 were $72^{1}/_{2}$ billion, from which we find that the average production per spindle per hour was 0.0375 lb, corresponding to a count of about 22. A similar study of the data for several years back indicated a change of less than one count. Again, one of the factors that we investigated fails to shed any light on our problem. Cotton consumption per year fluctuates 10 to 15 per cent above or below the average, production per spindle increases about 5 per cent, average count remains about the same, and the spindles drop from 38 to 28 million in 11 years.

At last, we come to hours of operation in the mills, and

particularly the spindle-hours run. From 1922 to 1929, wide monthly fluctuations occurred but total yearly spindle-hours were reasonably in line. From 1930 to 1936, spindle-hours have been considerably less as a whole, with 1933 and 1936 well up toward the old average. The trend of the hours run per spindle is on the upgrade and, in the early part of 1937, exceeded any previous records.

23,000,000 SPINDLES IN PLACE A REASONABLE EXPECTATION

The records are not any too conclusive, but probably the greatest single factor in relegating old spindles to the scrap pile has been the longer hours of operation of the better spindles. We should naturally like to know how much further this process must go before the industry is stabilized and we are again on an even keel. I will not attempt to make any predictions, but if we use certain basic data that we have, we may arrive at some indications of the number of spindles that we can run.

We will use the 6,100,000 bales as average consumption per year and the average count of 22. The number of spindles required to convert this cotton into yarn will vary with the number of hours they are operated, and, from simple computations, we get Table 1.

TABLE 1 SPINDLES REQUIRED TO CONVERT 6,100,000 BALES OF COTTON INTO YARN

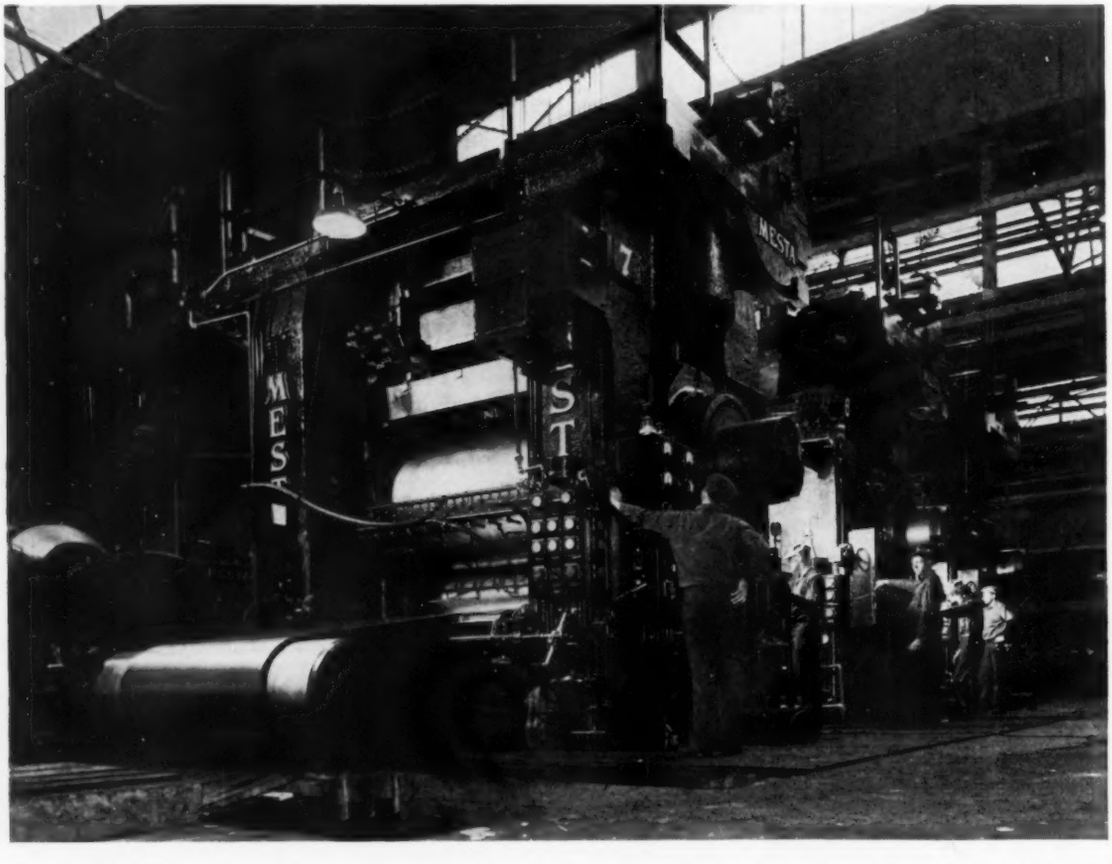
Operation, hr	40	48	54	80	110
Spindles.....	41,000,000	34,300,000	30,500,000	20,600,000	15,000,000

Spindles in place on Jan. 1, 1937, numbered 27,700,000. Probably some spindles, will always be inactive, for one reason or another, and, even in good times, this group has numbered at least 500,000. This figure should be added to Table 1 to arrive at the number of spindles in place.

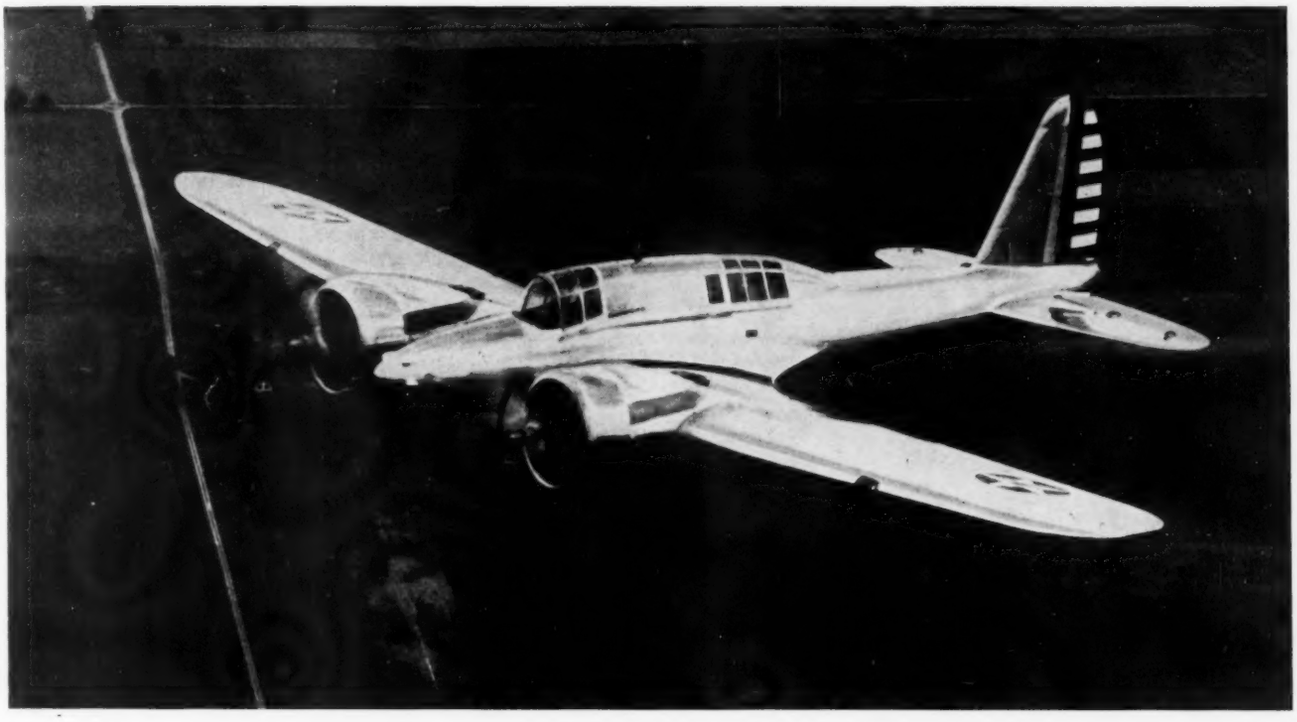
It is inconceivable that the industry will, in our time, operate one 40-hr shift, and improbable that it will operate, as a whole, at 110 hr per week in multiple shifts. The greatest likelihood is that it will settle down to two 40-hr shifts or 80 hr per week or, as an alternative three 30-hr shifts or 90 hr per week. Under the first condition, spindles required eventually will be 21,000,000 and, under the second, approximately 19,000,000.

Spindles in place on Jan. 1, 1937, were about 27,700,000 and the spindles reported as active numbered about 24,000,000. If we accept the premises on which these figures are based, we come to the conclusion that probably some 6,700,000 spindles are still to be scrapped, of which approximately 3,700,000 are now reported as active. Because some excess in spindles is required to meet style requirements and to take care of peaks, the reduction will probably not be as much as this. It would seem that a total of 23 million spindles in place would not be an unreasonable expectation.

I want you to remember that I am not making a prophecy but have used certain available data that cover a sufficient period to make them acceptable as an indicator and have arrived at certain conclusions. The answer may not be, and probably is not, correct, because of the many social and economic features that will affect it. However, taking into consideration the last 11 years' trend, the number of spindles scrapped last year, and the tendency to operate spindles a greater number of hours, I am convinced that several million spindles are still to go out before the industry is stabilized.



JONES & LAUGHLIN 93-IN. COLD-ROLLING MILL, FOUR-HIGH THREE-STAND TANDEM MILL, ROLLS COLD STRIP IN ONE OPERATION



CURTISS A-18 TWIN-ENGINE ATTACK MONOPLANE OF THE U. S. ARMY AIR CORPS

(Powered by two Wright Cyclone 1000-hp engines and equipped with retractable undercarriage and tail wheel to increase its flying speed, this all-metal mid-wing monoplane combines high performance at both low as well as high altitudes. It is equipped with six machine guns and carries a large bomb load.)

REVIEW *of* AERONAUTICS

Progress in the Last Year as Reported to the A.S.M.E. Aeronautic Division

FOR several years, the Aeronautic Division of The American Society of Mechanical Engineers has presented a report on progress in aeronautics which has been prepared by authorities representing various branches of the field covered by the Division. The following reports are an abridgment by Prof. Alexander Klemin, chairman of the Division, of the complete reports that were presented at the Annual Meeting, New York, N. Y., Dec. 6–10, 1937, of The American Society of Mechanical Engineers.

ADVANCE IN ARMY AVIATION[1]

The Army Air Corps has pushed energetically the development of large four-engine bombing planes, familiarly known as "Flying Fortresses." The latest example of this series, the XB-15 bomber, was completed and first flown on Oct. 16, 1937, and flying tests are still under way. This air giant is approximately 90 ft long and 18 ft high and its wing spread is 150 ft. Development of these high-capacity bombardment planes is one of the most important aeronautical developments to date. The automatic landing installation completed and tested at Wright Field in the summer has great significance for both military and commercial aviation. More than 50 landings have been made without a human hand touching the controls. Operation of ailerons, rudder, and elevator was entirely automatic, and the same automatic equipment applied the brakes and shut off the power. Air Corps engineers believe that, with this system, airplanes can now be landed in the densest fog. Great advances have been made in aerial colored, long-range, and night photography. With equipment now available to the Air Corps, pictures of a ship 150 miles at sea have been taken by an airplane flying above New York City. Another outstanding airplane development was in the delivery of the Bell XFM-1 multiplace fighter. Airplane-engine development is best exemplified by the production of a 1500-hp engine. Accessory experimental items include improved navigation instruments, gun tourelles, and aviators' clothing. The physiological laboratory has made exhaustive tests of the effect on the pilot of easement in altitude, pull-outs from dives, extreme cold, and rapid changes in pressure and temperature, including reaction time and the elapsed interval before return to normal.

Important studies in tactical progress have been made by General Headquarters Air Force, Air Corps Tactical School, and the Air Corps Board. Experiments have been made with new organizations and larger tactical units, and new methods of

[1] Prepared by Major-General Oscar Westover, U. S. A., Chief, Air Corps, Washington, D. C.

aerial combat have been studied. More than 500 new planes were procured for the Army Air Corps during the year. These included a small number of experimental types, but chiefly they were modern standard types of bomber, attack, reconnaissance, fighter, and training. The types of plane procured during the year by the Army Air Corps were the equal and, in many cases the superior, of those obtainable anywhere in the world, when judged by the light of the tactical missions and strategic functions they are called upon to perform in the Army Air Corps.

ADVANCES IN NAVAL AVIATION[2]

Lighter-than-air activities continued to be concentrated at the Naval Air Station, Lakehurst, N. J., where four nonrigid airships operated an average of 508 hr apiece in a program of training and experimentation which included exercises with submarine activities. The *U.S.S. Los Angeles* was used in a nonflight status for instruction and for experiments in mooring and handling tests.

The training of aviation cadets, Naval Reserve, was continued at Pensacola, Fla., during the fiscal year 1937, and 297 qualified and were on duty in fleet units at the end of the fiscal year. This project is doing much to relieve the acute shortage of regular officer pilots available as naval aviators.

Annual 14-day periods of training duty were conducted for all members of the aviation fleet reserve in the fiscal year 1937. The large number of fleet-reserve aviators on extended active duty to augment the complement of regular naval aviators in connection with the training of aviation cadets at the Naval Air Station, Pensacola, Fla., made it possible to provide training periods for a considerable number of the volunteer aviation reserve officers who previously had been deprived of this training through lack of funds. This training served not only to stimulate the interest of the volunteer group but also provided badly needed refresher courses.

Activities at the Naval Reserve aviation bases have been tremendously stimulated by adoption of the aviation cadet program. Candidates for appointment as aviation cadets are selected in the various Naval Districts in accordance with specified qualifications and assigned quotas. Preliminary selections are made by boards of officers appointed by various commandants, and final selection is made by the Bureau of Navigation. Selected students are given 30 days of active duty as seamen V-5 USNR and a course in elimination flight training with 12-hr flying, including, in most cases, at least one solo flight. The course also includes indoctrination in naval subjects. Upon successful completion of elimination training, candidates are appointed aviation cadets and ordered to the Naval Air Station, Pensacola, Fla., for the regular flight-training course. During the fiscal year 1937, 300 cadets successfully completed the course at Pensacola and were ordered to the fleet. Approximately 200 more will probably be ordered to active duty with the fleet in the 1938 fiscal year.

Development of a radio-meteorograph by the National Bureau of Standards for the Bureau of Engineering and the Bureau of Aeronautics has been continued during the year. Such excellent progress has been made that the Bureau of Aeronautics in the closing months of this fiscal year ordered 50 instruments for service test.

Uncertainty continued to surround future policy with regard to rigid airships for naval uses. Pending a decision by the Secretary, no further action is contemplated by the Bureau of Aeronautics.

Interest in nonrigid airships, or blimps, has been revived, and appreciation of the value of this type for certain activities is growing. Funds for two new nonrigid airships were included in the 1938 Appropriation Bill and contract for them will be placed at an early date.

Late models of all current service-type engines have shown gratifying increases in power output and altitude ratings. Crankshaft torsional-vibration dampers and full-pressure lubrication to cylinder valve gear, now standard in recent service types, have been so satisfactory that similar equipment has been supplied to certain earlier engine types when mechanical characteristics and economical considerations warranted such action.

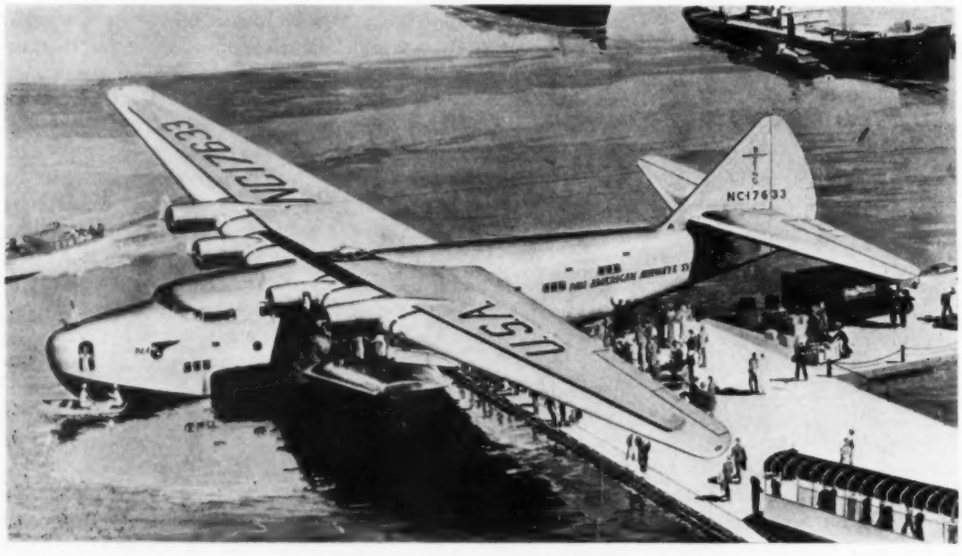
Similar development and test programs are in progress on accessory devices to meet the increasing complexities of modern power-plant installations, particularly as regards automatic regulation, to minimize demands upon the pilot's attention made by the power plant while in flight.

The program mentioned in the last annual report, covering measurement of landing accelerations and water pressures on seaplanes and flying boats, is under way. Valuable design information is expected to be obtained therefrom.

Investigation of vibration characteristics of airplane structures and the stresses resulting from vibration has been continued and considerable data have been obtained. Furthermore, effort is constantly being directed toward development of more reliable and accurate strain-recording apparatus for laboratory and flight studies.

Marked advances have been made as the result of basic research coordinated with service tests on various textiles, metals, protective coatings,

[2] Prepared by Rear-Admiral A. B. Cook, U. S. N., Chief of the Bureau of Aeronautics, Washington, D. C.



AN AMERICAN NEW SUPER CLIPPER NOW BEING BUILT BY BOEING AIRCRAFT

and shop processes. Spot welding, flush riveting, quick-drying protective coatings, lightweight alloys, and similar items have reached a high state of development and are now in production. An outstanding contribution to the advancement of aeronautics has been the development and adoption in the last year of a protective treatment for magnesium alloys which will doubtless increase their use. Lightweight cotton fabrics of domestic origin have been developed which appear to be satisfactory substitutes for parachute silk. Development of a new series of landing-gear wheels has been prosecuted and will result in a marked saving in weight for such equipment. The last year has also seen development of oxygen breathing apparatus of efficient design for high-altitude flying.

Development of airplanes of increased range and striking power will continue and greater simplicity of operation will be sought. Improved maintenance characteristics in new designs under construction are expected to be obtained.

Engines of improved reliability with greater horsepower and higher efficiency are in prospect. Approximately 256 airplanes and 494 engines were delivered during the fiscal year.

PROGRESS IN AIRPLANE DESIGN AND CONSTRUCTION[3]

Practically all new designs of 1937 were either of the low-wing or the mid-wing type, with tractor engines and retractable landing gear. The tendency toward stressed-skin construction, using aluminum alloys, which has manifested itself in previous years, had reached a point where it was standard practice in most of the leading countries throughout the world. However, in some countries, an interesting tendency toward the return to plywood-covered wooden structures has been manifest.

In the field of larger airplanes, the only new transport developed in the United States during 1937 which was not almost identical with previous machines was the Lockheed model 14, having a wing loading of approximately 28 lb per sq ft with standard gross weight and approximately 32 lb per sq ft with provisional gross weight. Power loadings were approximately 9.1 and 10.3 lb per hp, respectively, when based on take-off power. The speed of this airplane, which is powered with Pratt & Whitney Hornet engines, was considerably higher than any other commercial transport hitherto developed, being 248 mph at 7000 ft when using 750 hp per engine and 212 mph when cruising at 70 per cent power. However, when compared with available horsepower, seating and payload capacities are lower than on previous transport types.

Following the trend already established in previous years, the tendency toward using the nose wheel increased. This revival, which seems to have originated in the United States, was standard on the Stearman Hammond model Y and Waterman's "Airmobile" and was also available on a new type Waco single-engine airplane, as well as on the Gwinn biplane. These were the first production machines to make this available as standard equipment. The first two of these machines were pusher types, and the other two were tractors with the forward wheel located under the engine nacelle. Nearing completion at the end of 1937 was the Douglas DC-4, which is expected to be the first large transport airplane to have the nose wheel. Although service experience in regular operation with the nose wheel has not been extensive, this type of landing gear seems to indicate possible solution of ground-looping elimination and prove of great assistance in blind landings.

Because of high wing loadings, the tendency toward use of flaps and auxiliary lift devices has increased. The value of these or other auxiliary devices for producing glide-path control received more attention than previously. In most types, the desired drag was produced by extension of the retractable landing gear or use of split flaps. In general, wing flaps extended out only as far as the beginning of the ailerons, and conventional ailerons continued to be used. Wing flaps were of the split-flap type, which was common in previous years and later experienced a variation in having the flap ventilated by a great number of large holes as developed by Northrop and conventional aileron-type flap, as well as the Fowler-type flap. The last type, which actually increased the wing area, was used on an experimental Martin bomber and on the Lockheed model 14, where this flap, covering about 20 per cent of the wing chord, apparently was successful. This means enabled Lockheed to achieve its high wing loading.

AN ARMY MARTIN BOMBER EQUIPPED WITH THE ELECTRIC CONTROLLABLE-PITCH PROPELLER

In the multiengine field, only one pusher type of airplane was evidenced. This was the interesting two-engine attack plane that was developed by Bell Aircraft Company for the Army and has two liquid-cooled pusher engines mounted in the rear portion of the wing. Except for this airplane, general tendency in the United States was to use air-cooled engines. In the small-plane field, air-cooled in-line engines continued to be used although radial engines powered approximately 50 per cent of the small airplanes. Radial engines seem to have become standard practice in the field of the large airplanes, with an increasing tendency toward the 14-cylinder two-row arrangement for high-powered machines.

Cowl flaps were used in the United States on the two-row radials only for ground operation; while in Europe, especially in England, cowl flaps became standard practice on most radial types. Although the new N.A.C.A. type cowling, having

[3] Prepared by Richard M. Mock, Fokker representative at Douglas Aircraft Company, Inc., Santa Monica, Calif. Mem. A.S.M.E.

pressure baffles with cooling air exhausted near the leading edge of the cowl, was announced, no civil airplanes appeared which used this type of cowling. For low-powered radial engines, an interesting advance was closing the rear slot of the N.A.C.A. cowl at the top and having only a small opening at the bottom and sides.

As has been mentioned previously, the stressed skin of the aluminum-alloy monocoque or semi-monocoque structure is rapidly becoming standard practice throughout the world. Even England, which for many years avoided this type of structure, used aluminum alloys with the reinforced stressed-skin structure in most of its 1937 new designs. In this field, the tendency toward having the built-in tank integral with the airplane structure and the fuel in contact with the actual wing covering increased in use, although some schools of thought raised serious objections to this practice.

Spot welding continued to be used only on secondary structural parts on aluminum-alloy types. Spot welding, which a few years before was heralded as the limit in fabricating aluminum alloys, is now being questioned as to its manufacturing economy. This is possibly because considerably more effort has been expended toward economical riveting practice than on economical spot-welding equipment. Although no stainless-steel structures were manufactured in production, advocates of this type continued to make experimental types using spot welding as a means of fabrication.

In 1937, the subject of ice attracted considerable attention. The B. F. Goodrich Company in its refrigerated wind tunnel at Akron, Ohio, carried out some interesting research on the effect of icing of control surfaces, with the cooperation of all of the major air lines and the Douglas Aircraft Company. The general conclusion was that it is highly undesirable to have any balanced portion of the control surface project into the airstream because ice would accumulate on it thus causing overbalance or jamming of controls. Much research and development was done to improve the rubber-overshoe type of de-icer further to eliminate damage from static electricity, and other causes.

The largest airplanes of modern arrangement ever built in the United States were completed in 1937. These included the Boeing XB15 four-engine mid-wing bomber, and the Sikorsky XPBS four-engine patrol boat for the U. S. Navy. As this report is being written, the Martin four-engine 65,000-lb flying boat for the Soviet Government is nearing completion, and, early in 1938, the Douglas DC-4 four-engine landplane of almost the same weight is expected to make its first flights. The advent of these large airplanes has introduced many problems, whose final solution remains to be seen as all of these machines are new and experimental. One of the latest developments in this connection is the 110-volt alternating-current electrical system which saves considerable wiring on large airplanes but, however, has required the development of new motors and generators for the accessories. Practically all of the large airplanes have the four-engine arrangement and one or two auxiliary gasoline-driven power plants driving electrical generators for operating the accessories. Also announced in 1937, although not expected to be completed before 1938, are the two new Boeing projects, 90,000-lb four-engine flying boats for Pan American Airways and four-engine landplanes for Pan American Airways and TWA. The latter is approximately 45,000 lb, which is about the same size as the four-engine Junkers JU 90 which made its first appearance in 1937.

Last year many secret projects of stratosphere and substratosphere types of airplane were reported, although none came into general use. The Lockheed Company produced an experimental machine for the U. S. Army, while most of the other aircraft manufacturers had airplanes for this purpose under secret development.

PROGRESS IN AIRCRAFT ENGINES[4]

The most significant event for 1937 in the aircraft-engine field was the completion of laboratory development, and the introduction to experimental flight service, of the 1500-hp radial engines that have been under discussion for years, but only recently has the demand from aircraft manufacturers been sufficiently strong to justify actual development. Engines of 2000 hp are in view for the near future, at least one model having reached the endurance-test stage in the last year.

Another important development, almost revolutionary in character for the United States, is the installation of liquid-cooled Allison engines in the new Bell twin-pusher military airplane. One wonders if this may not mark the beginning of renewed interest in liquid-cooled engines in this country. In close connection with this should be mentioned a resumption of study of the much-neglected problem of radiator installation for liquid-cooled engines. Theoretical possibilities of reducing radiator drag to low or even negative values by enclosing the radiators within the airplane skin and providing properly located air inlet and outlet passages were at last appreciated.

Meanwhile work on improvement of the cowling and baffling of radial engines has been proceeding rapidly at the N.A.C.A. laboratories, and a new and promising cowl, the "nose-slot" type, has entered the flight-experimental stage. Work on the cowling and cooling of in-line air-cooled engines has also been initiated in the last year, and researches on blower cooling of air-cooled cylinders has been continued.

The year 1937 has also marked the beginning of systematic and thorough study of engine mountings with a view toward eliminating, as far as possible, the transmission of vibrations to the aircraft structure. A major contribution to this work has been new instruments for studying details of engine vibration, with engines freely mounted, and in actual flight.

An active interest in engines of less than 100 hp has been evidenced by the fact that several manufacturers started development of such engines during the year. This is encouraging to those interested in the low-priced airplane for private ownership, as heretofore not many satisfactory engines for this type have been on the American market.

Work toward the establishment of a satisfactory method of determining the octane number of aircraft-engine fuels has been continued in 1937, but this problem is not yet completely solved.

In spite of continued research in the aircraft Diesel-engine field and the attainment of good single-cylinder performance at the N.A.C.A. laboratories, no compression-ignition engine has yet been developed which can compete successfully with existing spark-ignition types. Rumor has it that even in the case of the German Junker engine production is being curtailed in favor of spark-ignition types. It is to be hoped, however, that continuation of aircraft-Diesel development will not be curtailed, for many qualified persons believe that eventually this type may find an important place in air transportation.

An event of the year which should not be overlooked was the completion of the new D.V.L. engine laboratories at Adlershof, Berlin. They are certainly among the finest and most complete aircraft-engine laboratories in the world and are manned by unusually competent personnel. It is to be hoped that results obtained from these laboratories will be made generally available.

[4] Prepared by C. Fayette Taylor, Professor of Automotive Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

HYDRAULIC STRUCTURES

A Review Prepared by William F. Durand[1]

THIS monumental work covers so wide a range of topics and with such wealth of detail and of illustrative material that no adequate presentation, either of content or character, can be made within the limits of the normal book review. Regarding content as measured in figures, the following may help in some degree.

In addition to the 1172 pages of text with the 2057 diagrams and half tones, there are 119 tables giving collections of numerical data and values of coefficients, with 673 bibliographical references distributed through the text, with more than 2000 entries in the index, indicating, in gross, something of the number of separate topics treated. The work as a whole is presented under 11 principal parts divided into 61 sections corresponding to what may be called chapters in the usual textbook sense.

An important feature of the work is that it is written with two quite different purposes in view—as a textbook for engineering students and as a reference work for practicing engineers. This double purpose calls for two different types of treatment. The student requires a clear statement of fundamental principles with a not too difficult development of the more important results, usually expressed in terms of formulas, often with empirical coefficients, the values of which must be determined by experimental research. He should also find in such a work a storehouse of information as to the best approved types, forms, and arrangements of the various structural items which enter into complete operating hydraulic structures. Of less importance to him are many items relating to engineering practice in the field—information which he can better acquire in the field by actual experience in the construction or installation of hydraulic structures.

On the other hand, the practicing engineer will be especially interested in formulas, coefficients, data derived from experimental research or tests, and likewise in drawings, designs, and descriptions of approved elements and features of which hydraulic structures are composed, as well as information of use in the field in connection with their construction and installation.

This double purpose presents sometimes a difficult problem as to the question of balance between matter of special importance to the student and matter of more direct value to the practicing engineer. Fortunately, there is a very large middle ground common to both. In general, as between these two types of service contemplated by the author, the balance seems to have been well maintained.

The author has recognized the impossibility, within the limits of any reasonable space, in a work of this character, to show in full detail the development of all formulas; and in many cases the reader is referred to special texts or papers where the development is shown more fully. As it is, the reader who wishes to follow through in detail the derivation of the various formulas and results, as expressed in mathematical form, will require some familiarity with differential equations and with functions of the complex variable. This could scarcely be otherwise; but the reader not acquainted with these mathematical disciplines must expect to take a part of the mathematical work on trust and to content himself with the final results as expressed in formulas with coefficients ready for use.

Approaching now a somewhat more detailed view of the work, it should first be noted that, by intention, the special subject of coast and harbor hydraulic structures, is not included in the treatment. The broad subject otherwise is presented under eleven parts as follows: First volume, six parts—part I, meteorology; part II, hydrology and hydraulics; part III, soils and soil mechanics; part IV, important building materials of hydraulic structures; part V, water-supply engineering; part VI, sewage. Second volume, five parts—part VII, dams, outlet works, and canal intake works; part VIII, hydroelectric plants; part IX, reclamation; part X, river engineering; part XI, waterways engineering.

Parts I to IV. While the first four parts of the first volume deal with subjects which do not lie strictly in the field of hydraulic structures as such, yet they form the background against which any treatment of such structures must be presented. Treatment of these subjects, adequate for the main purposes of the work, seems, therefore, indispensable; and such treatment appears to have been carried out with care and good judgment. The author disclaims any attempt at detailed and complete treatment of these subjects, including only those aspects which have particular bearing on subjects dealt with in the following parts. The major results are, furthermore, presented often in the form of empirical constants and formulas, rather than as derived by way of fundamental discussion. In this form they are intended to be of the most direct use to the designing engineer when dealing with problems of the character dealt with in the remaining sections of the work.

Again, in order to make possible a more adequate treatment of modern practice in these fields of engineering design, the subject of historical development has been omitted. This broad aspect, though of great interest, is not essential to the main purpose of the author, which, throughout, has been to furnish the engineer and the student with a reasonably adequate picture of modern approved practice in the field of the design of hydraulic structures and with the immediate background of theory upon which such practice must rest.

With this characterization of the work in broad terms, brief note may be made of the seven parts under which the engineering subject matter is dealt with.

Part V, covering 136 pages, deals with the general subject of water supply. This is dealt with under the principal heads of: purpose and scope; water consumption; quality; examination and test; treatment; works for the collection of water; distributing reservoirs; mains leading to distribution system; distribution system; special structures; house distribution; measurement—with many subdivisions under these major heads. As elsewhere in this work, the treatment abounds in tables of data, diagrams, formulas, and drawings of structures. The tabular data, drawings, and illustrative material are taken wholly from German sources and represent German standards and practice. Such data and illustrative material, while of interest as showing German standards and practice, cannot, of course, be used by American engineers without due caution. Thus merely as an illustration, the data on water consumption

[1] Professor Emeritus of Mechanical Engineering, Stanford University. Past-President, A.S.M.E.

A review of a book entitled "Hydraulic Structures," by Armin Schoklitsch. Translated by Samuel Shulits and Lorenz G. Straub. Published by The American Society of Mechanical Engineers, New York, 1937. Fabrikoid, $7^3/_4 \times 10^5/_8$ in., 2 vol., 1172 pp., 2057 figs., 119 tables, $18.

per capita for 14 German cities, while of interest as a matter of information, are of no value to the American engineer in estimating the consumption for American cities. This is not intended as a criticism on the work as such, but only as a caution in connection with the use of numerical data which may or may not apply to conditions in other parts of the world. However, as a general exposition of the subject of water supply and of the essential elements of this phase of engineering work, and of the methods and materials available for dealing with these problems, the treatment of the author seems excellent. To select only one item among many, note may be made of the discussion of distribution systems in chapter IX.

Part VI, covering 114 pages, deals with the general subject of sewage under the major divisions of: purpose and scope; quantity; composition and condition; disposal and treatment; collection and removal; special structures—again with many subdivisions, especially under the head of disposal and treatment. Here again, the treatment of the subject abounds in tabular data, diagrams, drawings, and illustrative material, drawn from German practice and hence subject to the same caution as for the preceding part. Among many other items of interest here, note may be made on pp. 436 and 437, of a series of diagrams giving the flow characteristics (velocity and quantity) of 19 different forms of cross section of sewer conduit, together with, on p. 439, tabular values of the principal hydraulic characteristics of these sections.

Part VII, covering 263 pages, deals with the general subject of dams under the headings of: immovable dams, movable weirs; regulators and their arrangement; traffic ways at weirs; weir substructure and foundation; weir failures; canal intake works —with numerous subdivisions under the first heading which deals with the subject of dams in the more common use of the term. These are treated under the two principal heads of embankment dams, including earth fill and rock fill; and masonry dams, stone masonry or concrete. The latter again are treated under the heads of gravity, arch, and buttress dams.

As elsewhere, part VII is replete with data, diagrams, drawings, and illustrative material, drawn chiefly from German practice, but including a number of examples of practice elsewhere, mostly from the United States. The original writing of the work was apparently too early to permit reference to or description of the method of building large massive concrete dams in separate vertical blocks, with suitable keys and keyways formed in the transverse and radial joints, with artificial cooling through an embedded system of piping, and followed by grouting of the joints between the blocks, thus securing a monolithic structure. This method, as employed by the U. S. Reclamation Service in the Boulder and Grand Coulee Dams, may be considered standard in the United States for concrete structures of the largest size.

The analytical treatment of stresses in dam structures is brief with references elsewhere for a more complete discussion. In particular is this true with reference to arch dams where no discussion of stress analysis is given. This choice on the part of the author was presumably dictated by the impossibility of any adequate treatment of this phase of the subject within a space which could have been permitted in a work of this encyclopedic character, and by the existence of the more detailed discussions of the subject as given in the bibliographic references. The date of writing also, apparently prevented reference to the method of "trial-load analysis" as developed by the engineers of the U. S. Bureau of Reclamation, especially for the investigation of the stresses in the Boulder Dam on the Colorado River, and since applied to other arch dams.

While there have been, therefore, since the original preparation of this work, notable advances in the methods of stress analysis for concrete dams as well as in the technique of construction for very large dams, this section of the work, the longest but one in the book, contains a wealth of material of great interest and value and will repay careful attention on the part of engineers dealing with these phases of engineering work. Of special interest, note may be made of the chapters on weir substructures and weir failures.

Part VIII, covering 278 pages, deals with hydroelectric plants under the headings of: development of power; structures of hydroelectric development; special installations; small water-power stations—with numerous subdivisions, especially under the second chapter on the structures of hydroelectric development. Due to the relation of the subject of power development to the central theme of the work as a whole, the treatment of this subject is, for the most part, descriptive and illustrative rather than analytical and theoretical. Brief analytical discussions, are, however, given in connection with the subjects of penstocks and their design, surge tanks, the design of draft tubes, and reaction turbines. There is, in this part, an especial wealth of illustrative material including tabular data, diagrams, drawings, and half tones. As elsewhere, this is drawn chiefly from German sources. Among many other items, these comprise data on 30 run-of-the-river and 18 storage power developments; data on 20 existing pressure tunnels; some 90 cuts, half tones, and powerhouse sections, showing various types and forms of turbines, and powerhouse installations; like illustrative material relating to auxiliary features and structures —valves, trash racks, sand traps, energy dissipators, and governors. A minor criticism may be noted regarding inconsistency in the naming of the Pelton type of hydraulic prime mover. For the most part is it called a Pelton turbine (see pp. 930, 967, 969, 970, 971) but on p. 966 it is Pelton wheel, on p. 981, tangential wheel and on p. 1010, an impulse wheel. So far as the present reviewer is aware, the term "turbine" is not used, at least in the United States, in referring to this type of hydraulic prime mover. Pelton wheel, Pelton water wheel, impulse wheel, or tangential wheel are all used more or less indiscriminately.

While the reader will note the omission of data and illustrative material drawn from notable American examples of hydroelectric power installations, this section contains, nevertheless, such a wealth of data, drawings, and illustrations of German practice, together with so complete a view of the entire problem of hydro-power development, that no engineer dealing with these problems can fail to find here matter of the highest interest and value.

Part IX, covering 25 pages, deals with the subject of reclamation under the heads: land drainage; irrigation—with subdivisions under each head. This subject is dealt with only briefly, and primarily, of course, in relation to the structures involved. Ditches, drainage, and pumping stations form the major subdivisions of the first heading. The second heading is treated under irrigation by flooding; subirrigation; spray methods. As elsewhere, there is a considerable amount of tabular and illustrative material with a theoretical discussion of the factors and conditions involved in irrigation by flooding over gentle slopes by water overflow from the lower edge of ditches running nearly along contour lines. The data furnished regarding the variation of water duty for various crops through the six months, April to September, inclusive, applies, of course, only to Germany and to German practice in these matters. Arising from the nature of the broad subject of reclamation, this division of the work has, presumably by intention, been treated less completely than the other major topics. Enough has been included, however, to show the general character of

(*Continued on page 140*)

Recent Developments in HOT PRESSING *of* PLYWOOD

By E. H. MERRITT

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FOUR YEARS ago I presented a paper on resin-bonded plywood. According to the published program, my subject is "Recent Developments in Resin Bonding," but I have taken the liberty of broadening the subject to "Recent Developments in the Hot Pressing of Plywood." Because so much recent development in resin bonding applies equally to non-resinous adhesives employed in the hot press, I believe a broader treatment of the subject is indicated. Here in the States, perhaps because resin bonding and hot pressing both appeared on the scene at approximately the same time, the rather erroneous conception has developed that the two are synonymous.

Resin bonding is not confined to the hot press. Some synthetic resins can be converted to an insoluble state chemically as well as by heat and pressure. On the other hand, plywood adhesives suitable for hot-press use are not confined to the resins. For many years, before the advent of synthetic-resin plywood adhesives, the standard method of laminating plywood, particularly in the birch mills of the Baltic States and Russia, was by the hot-plate press, using various blood and casein glues. In the northern European birch mills, that is still standard procedure, little resin being used.

Since some developments touched upon in this paper will necessarily involve hot pressing of plywood but will have no connection whatsoever with resin, this distinction between resin-bonded and hot-pressed plywood must be kept clearly in mind. To touch more than briefly upon a few developments in hot pressing will be impossible on account of time and space limitations and also because much of the development work here enumerated has not yet reached the point where entering into details is either wise or expedient, and further data on operating results are needed. Let it suffice at this time to point out briefly the trends that some of these developments are taking.

NEW RESIN ADHESIVES REQUIRE SPECIAL EQUIPMENT

One major point in connection with resin bonding has been the development of a zinc-chloride–urea-formaldehyde resin and also of various straight urea-formaldehyde resins suitable for plywood bonding. Both resins are highly reactive, yield a white colorless glue line, and set up in a remarkably short time at low temperatures.

Zinc-chloride–urea-formaldehyde resin is produced and marketed as a white crystalline powder which is dispersed in water and makes a liquid glue. Straight urea-formaldehyde resins are, at present, offered to the trade in liquid form. In some cases, the viscosity of this liquid adhesive as received from the producer is too low for direct spreader application. Consequently, it must be thickened by adding some relatively inert material, usually a cheap rye or wheat flour.

Comparing various methods of applying adhesives to the surface of a sheet of veneer in the production of plywood is beyond the scope of this paper. The trade is familiar with the fact that the adhesive as applied may take the form of a dry film, dry powder, spray, or liquid used in a roll spreader. The last named is the most familiar to operators of the cold gluing process and, since hot pressing is not confined to resins, this means appears to have the widest range of usefulness. Suitable equipment for applying modern liquid adhesives with any satisfactory degree of efficiency follows the choice of such adhesives.

Application of the newer resins might be thought to present no problem of application but no one ever seriously claimed that the conventional glue spreader of today is a piece of precision equipment. It has served its purpose well enough in average furniture and panel plants but its shortcomings have been recognized for some time in the large plants producing fir plywood on the West Coast and in some of the larger box plants where consumption of even a low-priced glue is a major item of cost. With the usual starch or soy-bean glues, 120 lb of wet glue is the minimum per 1000 sq ft of double glue line.

When using one of the newer resin adhesives for bonding in a hot press, a spread of from 40 to 60 lb per 1000 sq ft of double glue line is sufficient. Therefore, in general, our spreading problem of a wet adhesive for hot-press bonding involves uniform application of only approximately 40 per cent of the glue used in conventional cold pressing. To accomplish this, considerable research has been necessary in connection with roller application of liquid adhesive to single-ply veneer.

OPERATION OF THE CONVENTIONAL GLUE SPREADER

Two methods of operating the conventional glue spreader are in general use. One is to allow the top roll to ride on the stock, varying the pressure exerted upon the sheet by either spring or counterweight adjustments. Here, we have virtually the elements of a downward-acting press, the bottom roll serving as the base. The top roll acts as the pressure-applying medium and exerts a uniform total pressure. Consequently, if first we feed a wide sheet through the spreader and then a narrow one, we apply a low unit pressure to the former and a higher one to the latter. As a result, the spread on the narrow sheet is lower than on the wide.

The other method virtually locks the top roll in a fixed position. In this case, the space between the two rolls must be such that their lands will cut through the film of adhesive and grip the sheet with sufficient force to give a positive feed. With this construction, no variance in spread between a wide and a narrow sheet is obtained, but the pressure exerted on veneer of a given thickness varies over a wide range with slight differences in thickness. Since commercial single-ply veneer does vary in thickness, we have a light or a heavy spread, depending upon whether we pass a thick or a thin sheet through the spreader. Solution of this problem might appear to be some type of roll having sufficient resilience to give positive feed to a sheet of single-ply veneer where thickness variations would not exceed commercial limits. In that case approximately

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uniform pressure could be expected and some type of rubber roll would appear to be the logical answer.

A second shortcoming encountered in attempting to adapt a conventional spreader to precision application of the minimum of glue lay in the difficulty of controlling the quantity doctored onto the roll. First, choice had to be made between a smooth roll and one grooved to receive a definite charge of glue. The latter seemed to offer the best approach toward precision doctoring of glue. To obtain this result requires a rigidly mounted doctor bar that can be easily and conveniently adjusted locally and will hold its adjustment permanently. Because these bars control the quantity applied to the veneer, they must have a convenient quick adjustment for full-length movement parallel to the axis of the rolls.

In a precision spreader, the rolls themselves must be of ample diameter to avoid deflection and extremely accurate as to uniformity of diameter and concentricity. They should also be carried in preloaded antifriction bearings of adequate size. Spreading equipment incorporating these features is now available.

As thinner and thinner veneers are used, spreading them by a roller spreader becomes more and more difficult. To meet this condition, some trend toward applying resin adhesives by sprays has been noted. This is particularly true in Europe and we shall undoubtedly hear more of this method in this country in the near future.

HOT PRESSING AND LOW SPREADS

When resin adhesives first appeared and exceedingly strong bonds were produced with relatively low spreads, the high character of the adhesive itself was assumed to make these low spreads possible. Now the fact is well-established that, compared with cold gluing, hot pressing of itself permits using much smaller quantities of adhesive, all other conditions being equal. When we stop to analyze the problem it becomes more or less obvious why this is so. Under the influence of pressure and heat and in the presence of a certain quantity of moisture wood develops some plasticity. These conditions are present in hot pressing and, as a result, the veneer plies have a more intimate contact in the hot press than in a cold press even with equal pressure. Consequently, excess adhesive is not required to fill the voids that are present when sheets of single-ply veneer are pressed together cold. The extent to which the glue spread in hot pressing can be reduced below that required for cold pressing depends upon (*a*) uniformity of the spread, (*b*) uniformity of the veneer thickness, (*c*) time and temperature required in the press for that particular adhesive, (*d*) rigidity of the hot press, and (*e*) flexibility of the plates themselves. The first four of these factors have been fairly well recognized but we find that the fifth one gives rise to an important development that is worthy of some attention. It is the fixed factor in the picture and an important element in the press design.

FLEXIBLE HOT PLATES

Wood being a nonhomogeneous material and not available commercially in sheets of absolutely uniform thickness, securing perfect intimacy of contact between a series of single-ply sheets is impossible without appreciably densifying portions of the wood unless the pressure is applied uniformly over the surface by a somewhat flexible medium. Uniform contact can be secured with relatively low pressure if it is applied by a perfectly flexible medium as surprising results obtained with the vacuum veneering process have demonstrated. Here wide variance in results is produced by direct application of pressure to the panel through a flexible sheet of rubber compared with a rigid caul. The marked difference between the top face of a flat lumber-core panel made in a vacuum bag where atmospheric pressure has been exerted directly through the flexible rubber sheet and the bottom surface where pressure has been exerted through the lumber core against the tray supporting the panel inside the bag is scarcely believable. The latter surface will be relatively smooth because the high spots have been pressed down and more or less leveled up with the low spots. A bond so produced will be perfect only at the spots receiving maximum pressure and deficient at those where pressure was inadequate if not entirely lacking. On the top where uniform pressure has been applied through the rubber to every subdivision of the surface, the contour will be uneven but the bond itself will be uniform because each subdivision of the glue line has received the same pressure.

The chief advocate of the flexible plate in hot pressing uses its own patented flexible electrically heated plates. With such a plate, a high degree of flexibility is secured but the leveling or averaging effect secured by hot pressing with conventional rigid steam-heated plates is entirely sacrificed. Flexible plates produce a panel of maximum uniformity of bond but requiring maximum sanding to produce a uniform thickness. Total variations in thicknesses of individual plies appear as variations in thickness of the entire panel which must be taken out by the sanding machine. With completely rigid conventional drilled steam plates, maximum smoothness and uniform thickness of panel are secured together with minimum-sanding requirement. However, with these plates, maximum sacrifice in uniformity of bond occurs, and the bond is a direct function of varying veneer thickness and rigidity of the press.

Extended study of various results secured in hot pressing both with full-flexible and almost totally rigid* pressure-applying means has convinced the writer that some compromise is indicated for best commercial results. With that belief, an entirely new type of hot plate has been developed and experience in eight or nine months of commercial application indicates its advantages. This has been particularly true in the production of fir plywood which is notoriously lacking in uniformity of thickness and homogeneity.

LOW-TEMPERATURE HOT PRESSING

That the construction which produces flexibility in this new type of hot plate also makes using low-temperature steam possible is fortunate. Further data on this phase of its performance will soon be available. Development of a technique for what might be termed low-temperature hot pressing is of major importance. This process has been in commercial operation on the Pacific Coast for the last eight months and involves using nonresinous adhesives at an average temperature of 215 F. It has been particularly adapted to coniferous woods which generally show maximum deterioration from the application of too high a temperature in the hot press.

A NEW TYPE OF NONRESINOUS GLUE

Perhaps the development that promises to exert the greatest effect upon hot-process plywood production is a new nonresinous adhesive that is being used in low-temperature operations. This is a mixture of powder and water in the form of a mastic. These glues are available in several types and are formed of low-priced base materials in such a way as to develop their maximum strength. Spreads are low, less than 10 lb per 1000 sq ft of single glue line, and new designs of mixing and spreading equipment are necessary because of the consistency. They develop a bond at 215 F, but hydraulic pressures up to 200 lb per sq in. are advantageous even on soft woods.

(*Continued on page 140*)

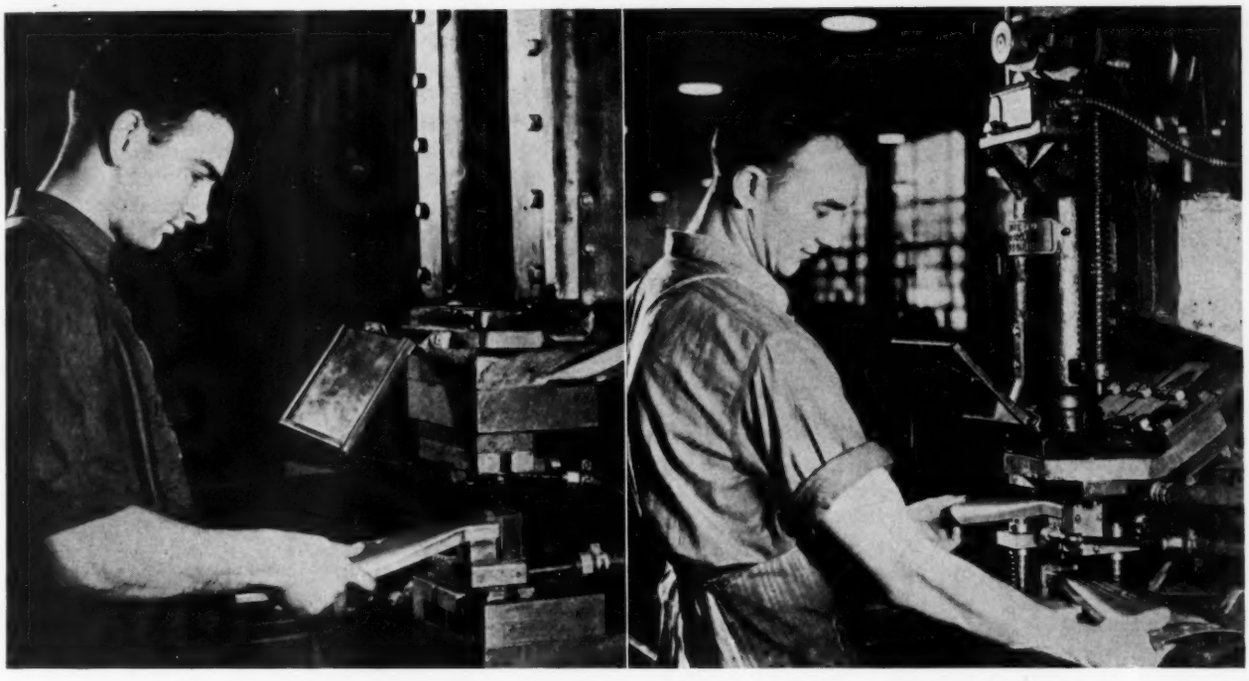

FIG. 1 WELDING CASTER SOCKETS TO WASHING-MACHINE LEGS

(These two views illustrate how an application of electric-resistance welding was changed from one assembly at a time (left) to two at a time (right) with an increase in output of 35 per cent.)

RESISTANCE-WELDING FABRICATION

Spot, Seam, Projection, and Butt-Flash Methods

By J. M. COOPER

PHILADELPHIA REPRESENTATIVE, THE TAYLOR WINFIELD CORPORATION

IN THIS paper, an attempt will be made to review the several forms of the resistance-welding process, pointing out the features characterizing each along with general comments covering applications and recent improvements. It is hoped that the extensiveness of the process will be made apparent and that it will be realized that modern resistance welding offers possibilities in practically every branch of manufacturing. The subject will be handled by discussing separately spot, seam, projection, and butt-flash welding.

The resistance-welding process is undoubtedly the outstanding fabrication process in the metal-parts industries, a veritable modern Aladdin's lamp that has accomplished feats of joining metals in a manner so simple, so quick, and so useful as to appear almost magical. What could be easier than merely to bring two objects together and, with a flash, have them unite, or to press them together at desired points of fastening and have an impulse of electric current bond them perfectly? This is precisely what modern resistance welding accomplishes in a manner that is as dependable and as understandable as any other machine-tool process.

Fundamentally, in the resistance weld, the welding action itself is based on the theory of the recrystallization of the metal. Heat is applied to bring the metal to a plastic state and pressure causes the grains to deform and grow across the interface boundary that separates the two pieces, resulting in a weld. The heat necessary to soften the materials is generated by the passage of a heavy electric current flowing through the resistive path of the metal, and the forging pressure is applied either by forcing the objects themselves together as in butt and flash welding or by the pressure on the electrode as in spot, seam, or projection welding. Resistance welding is therefore metallurgically ideal, inasmuch as the resultant weld metal has a forged or worked structure, differing but little from that in the original material. A modification in the generation of welding heat is found in flash welding, where a controlled arcing is set up between the parts being welded and the heat is the combined re-

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FIG. 2 DIFFERENT TYPES OF COPPER-WIRE TERMINALS THAT WERE WELDED ON A PRESS-TYPE MACHINE USING TUNGSTEN ELECTRODE TIPS

sult of the temperature of the metallic arc and the current flowing through the resistance of the material adjacent to arcing surface. Nevertheless, plastic and not molten material is what is forged together, any fluid metal being forced out.

SPOT WELDING

By spot welding is meant the production of a highly localized weld or spot by a welding tip or electrode. This tip causes a concentration of heat and pressure of proper proportions to cause a weld. Although appearing in several forms, such as manual, foot, or motor-operated, and press, portable, jig, and Hydrospeed types, spot-welding apparatus is basically composed of a low-potential high-current transformer with suitable conductors for carrying current to welding tips, a system for exerting force on electrodes, and provision for turning current on and off at the proper instant in the welding cycle. Spot welding is ideally suited to sheet-metal goods and to metal parts of all descriptions, providing it is not justifiable to handle them as a projection or butt-flash weld.

Manual or Foot-Operated Spot Welder. This is the form of resistance welder that is most commonly used. Because the welding cycle is controlled by the operator's judgment, a certain degree of skill is required to operate it successfully. Fortunately, on light-gage sheet metal, required welding conditions can vary considerably and on this class of work this machine finds its most extensive use. A feature of the manually operated type is that the motion of the electrodes down toward the work is under constant control of the operator's foot and thus facilitates positioning of parts being welded, which is convenient on wire goods and on small parts. On high-production parts that are bulky and hard to handle, or that lend themselves to multiple-projection welding, the desirability of the manual spot welder is challenged by newer types of equipment.

Recent improvements in manual spot welding would include (*a*) use and appreciation of the new water-cooled alloy tips, (*b*) protection of slender welding tips through using short-duration current impulses which is made possible by weld timers, and (*c*) general improvements in spot welders themselves, such as water-cooled transformers, better leverage ratios, and lowered mass and inertia in moving parts.

Heavy-duty air-operated spot welders should be mentioned in this section because of the widespread extension of spot welding on $^1/_8$-, $^1/_4$-, and $^5/_{16}$-in. plate and angle-iron work. With these machines, the operator can obtain the necessary heavy pressures and may "pump" or interrupt the flow of current into a series of pulses which helps to break through oxides and preserve the points by allowing electrode water cooling to dissipate destructive heat accumulations. Special thyratron panels are also available which will interrupt the welding current into a series of pulses.

A rust-preventing paint has also been developed which will protect inside surfaces without interfering with welding.

Power-Operated Spot Welder. In this type the foot machine is simply motorized, offers faster operating speeds, causes less fatigue to operator, and reduces the skill required. These machines are mostly used on sheet-metal parts where many welds are made in rapid succession and where liberal clearance around both upper and lower arms is necessary.

Press Type of Spot Welder. This machine represents the

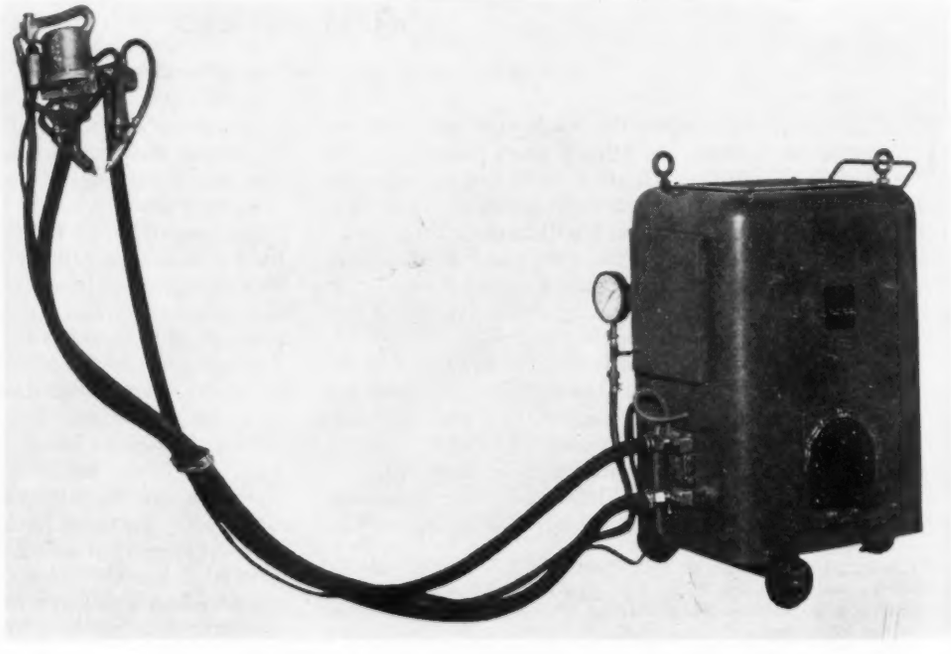

FIG. 3 PORTABLE SPOT OR GUN WELDER

(In this form of machine, the power is supplied by a stationary transformer through flexible water-cooled cables. It is used for welding bulky objects.)

most ideal equipment for spot welding, as it is characterized by (*a*) fully automatic mechanical operation, (*b*) a moving electrode held in a head that works up and down in a quill or slide, giving a true vertical motion to the electrode as differentiated from the arc through which the spot-welder arm swings, (*c*) low mass in moving parts so that impact to electrodes is lessened when operating at high speeds, (*d*) easily adjusted and calibrated pressure devices such as air cushions or springs, (*e*) readily adjusted timing cams when an external electronic control is not used, (*f*) 16 or more points of heat control, and (*g*) variable-speed drives. Many refinements of the press type of machine have made it practical to spot weld most of the nonferrous alloys such as the bronzes, brass, and aluminum. A characteristic product of the press-type welder is illustrated in Fig. 2. In conjunction with an electronic control, such as the thyratron or ignitron, it provides an ideal machine for spot welding stainless steel, a material requiring extremely short current duration to limit carbide precipitation, or for making one or two electrical-cyle welds on sheet metal which are noted for their lack of surface deformation and discoloration at the weld. Referring to the resistance-weld theory, metals only need to be heated to their plastic range of temperature so that under ideal conditions, the press welder will permit spot welding to be done with absolutely no sign of sparking or splashing out of molten metal. When metal is permitted to blow out from betwen two sheets, a contraction or shrink spot is formed, making finishing difficult.

Portable Spot or Gun Welder. This is a specialized form wherein a small yoke or frame carries the spot-welding dies along with an air cylinder to actuate the moving electrode, connection to a stationary transformer being made through flexible water-cooled cables as shown in Fig. 3. Such equipment has provided an invaluable tool for welding large bulky objects, of which the automobile body is a good example. It has also worked out ideally on moving assembly lines permitting welds to be made on the "fly." Gun welders are semi-automatic, the operator simply presses a valve actuating the cylinder and, when the proper pressure is exerted, a switch throws the automatically timed contactor and completes the weld. Rapid work can be done, as only from one tenth to one third of a second is necessary to produce a weld.

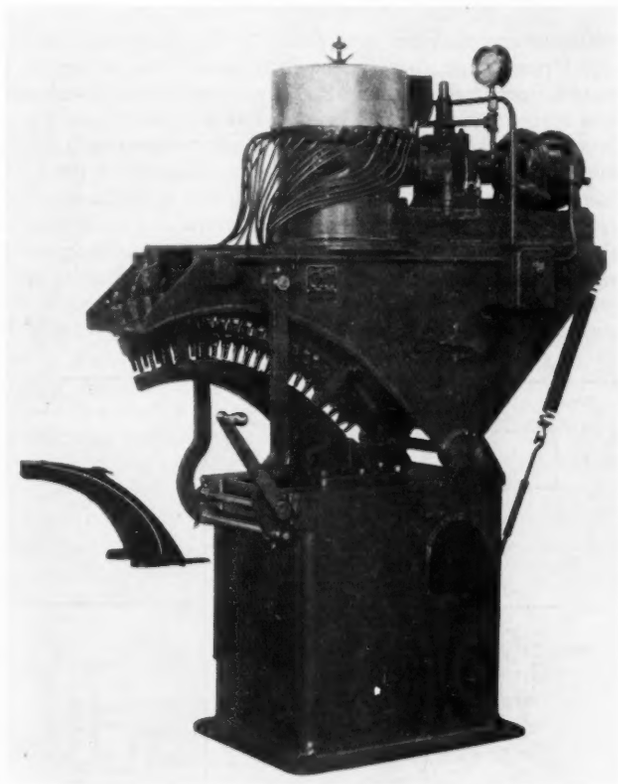

FIG. 4 THIS MACHINE CAN MAKE 42 WELDS IN SERIES

(Individual welding heads are mounted on the holding fixture and are brought into action rapidly and successively by oil pressure. Machines of this type can be supplied with 150 heads.)

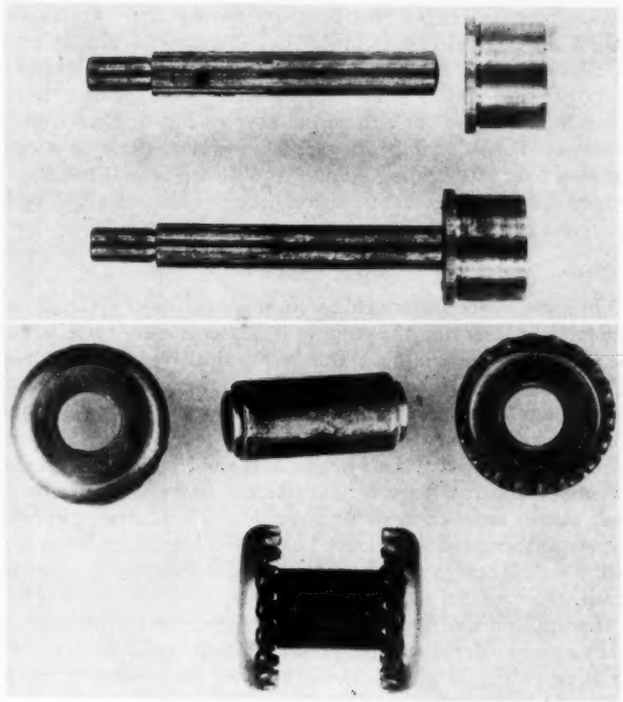

FIG. 5 TWO EXAMPLES OF PROJECTION WELDING

(Upper view shows a splined shaft before and after it was welded to washing-machine wringer-roll driving cup. The shaft, which is $^{9}/_{16}$ in. in diameter, has a radius on the end and was welded to within 0.008 in. concentricity with roll driver. Lower view illustrates use of projections that are swaged on the shoulders of a sleeve to permit welding of washing-machine wringer-gear stampings.)

Other forms of portable spot welder are used, these being mainly either an adaptation which is constructed so that the arms and machine itself can be swung in almost any position, making it truly universal, or a form of mobile welder arranged for series welding, the transformer and both electrodes being on one side of work while a shunting backup device is used on the other. Such machines are in use in the fabrication of bulky laundry machines and railroad cars.

Pry-Bar or Jig Welder. This is used extensively in the automotive field and may provide the answer to a difficult welding problem. In this apparatus, the sheet material to be welded is clamped in a copper fixture that constitutes one terminal of the transformer secondary circuit. The other end of the secondary is connected to a bar or rail that is bent up and around following the weld-line contour. A copper pry bar, equipped with welding tip, is brought to bear against the outside bus bar that it uses as a fulcrum and presses against the material at the location where a spot is to be made. Current is turned on by a switch located in the handle of the bar and the weld is completed.

Hydrospeed Spot Welder. This is a specialized apparatus having a multiplicity of individual hydraulically operated welding

heads mounted in various positions around the fixture that holds the object to be welded. Oil is shot into the different welding-head feed lines by a distributor valve and each head is brought into action in rapid succession. One welding transformer may serve for a large number of heads, the machine shown in Fig. 4 having 42 of these. However, a large machine, having over 150 welding points, would need several transformers in order that several welds on different circuits could be in progress at the same time.

SEAM WELDING

In a resistance seam weld, a continuous line of welding can be produced, serving the purpose of either sealing vessels pressure tight or providing a line of physically strong welding. Countless containers of every description, including automotive gasoline tanks, grease drums, paint pails, refrigerator evaporators, range boilers, and transformer tanks, have found increased strength and lowered costs in the seam weld. Many and varied forms of apparatus are used, machines having been built to suit almost every conceivable condition. In general, pieces to be seamed are passed in a lapped condition between two copper-alloy welding disks that concentrate the current along a narrow path.

Except in a few instances, the welding current is interrupted into a series of pulses that produce an alternate heating and cooling action in the weld metal, thus preventing excessive heat accumulations that might build up were the current permitted to flow continuously. The weld can be made on a lap or away from all edges. Speeds vary from approximately 3 fpm on 11-gage stock to 30 fpm on 22-gage. In all cases, surfaces at the line of welding must be clean and free of all oxides or scale. Stainless steel, aluminum, and brass can be seam-welded, providing consideration is given to the special conditions they require.

PROJECTION WELDING

By projection welding is meant that general class of welding wherein some kind of projection is processed into or on the part which will cause heat and pressure to localize for a weld without depending on the concentrating action of an electrode tip. As the spot-welding tip can be a prolific source of trouble, if not carefully maintained, the advantage of using a projection that consistently presents uniform size and conditions is obvious. It also makes possible multiple welds with a resultant increased production rate. In many cases, the mark left on the material by a welding tip can be eliminated by using an embossing on one of the parts and a broad smooth-surfaced electrode against the finish side. Several typical examples of projections that have been found useful for resistance welding will be discussed later.

As stated before, projections can be welded in multiple and, as this increases the transformer capacity and pressure requirements, and also necessitates accommodations for welding die sets, a new class of machines has been brought out to suit this work. Projection welders have die-holding platens, one of which is mounted on a rugged knee and the other on an upper head that moves up and down in close-fitting slides. Pressure can be applied through toggles or hydraulic cylinders, and its magnitude is readily adjusted. Large water-cooled transformers with cast-copper secondaries supply the heavy welding currents that are usually necessary. In all cases, the entire operating cycle of the machine is fully automatic, welds being usually made in a short time with a high energy input. As projection welding offers numerous possibilities and, therefore, finds so many varied applications, two of these being shown in Fig. 5, the equipment is made flexible as to adjustments of heat, pressure, and time, so that quick changes from one job to another can be made. Customary procedure is to invest in machines with sufficient reserve welding capacity to take care of the inevitable future heavier welding jobs. The automatic press-type spot welder offers an ideal machine for small compact projection patterns on light-gage parts. Dial or automatic feeding of projection welders is extensively done. Because current is not concentrated by the die itself, a welding alloy of copper and tungsten is generally used and gives long life to die sets.

TYPICAL EXAMPLES OF PROJECTIONS

The several sketches reproduced in Fig. 6 illustrate several useful projections that can be incorporated in the design of parts for resistance welding, (*a*) showing the simple and common form of projection. It is desirable to have a crown or dome so that the weld may start as a point contact and have a continuously increasing cross section to the finish of the weld. Size of the projection is determined by the strength required, number of projections used, kind of material and desired degree of freedom from marking, and size and space available for welding. No definite rule can be given. Each design must be based upon the particular factors controlling it. However, a few suggested sizes are given on the drawing. Care should be

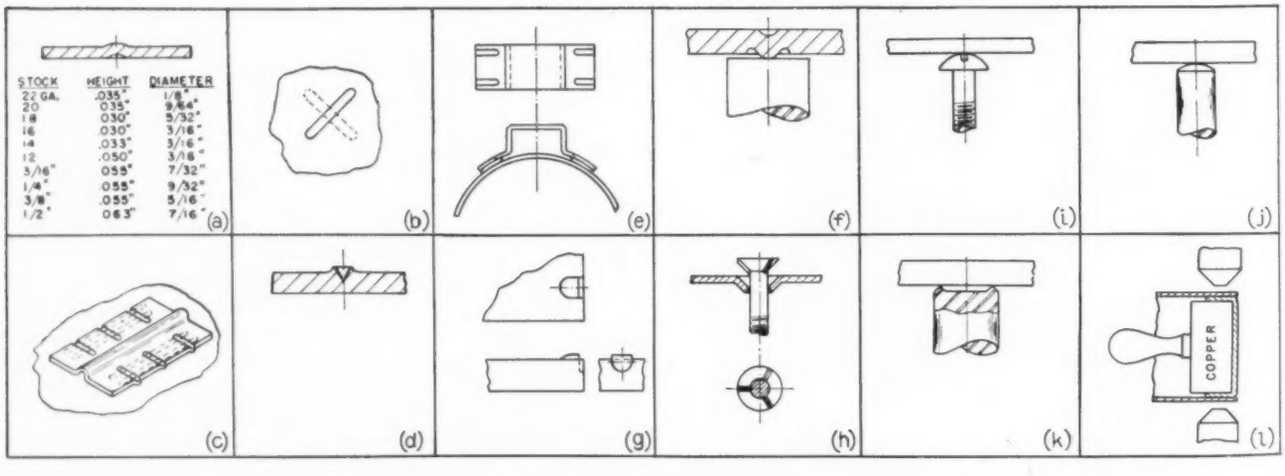

FIG. 6 TYPICAL EXAMPLES OF PROJECTIONS THAT CAN BE INCORPORATED IN THE DESIGN OF PARTS THAT ARE TO BE RESISTANCE WELDED

taken that the punch is the right size and is round-nosed so as not partially to shear a slug out. The embossing should be placed on the heavier of two thicknesses wherever this can be done.

Sketch (*b*) is the cross-elongated projection combination used on 24-gage and lighter sheet. This crossing of elongated projections facilitates welding. A practical application of this principle is the welding of handles to tin oil drums as shown at (*c*). In this case, the projections are ribs crossing at right angles.

The "prick-punch" projection where the rim thrown up around the punch mark serves as a suitable projection for welding light material to a heavier piece that carries the punch mark is illustrated at (*d*). Sketch (*e*) shows an elongated projection that is used on curved surfaces or other places where a slight longitudinal or transverse movement may occur. This projection is to insure ample contact surface in the direction in which the movement is likely to occur.

Sketch (*f*) shows a projection brought up on a heavy piece of material with a crater-like ring coined in around it. The purpose of the groove is to take any fused or upset metal and allow an intimate contact between welded surfaces. A scheme that is used for bringing a projection up from the side of a heavy section is illustrated at (*g*). This type is made by striking the edge with a punch whose face is half on the stock and half overhanging it.

How a cold-headed part can have ribs or any other suitable projection forged on it to facilitate welding is shown at (*h*). The countersunk hole in this case was used for location as well as to give good bearing to the flathead screw. A reminder of the ease with which studs and screws can be butt-welded to a surface is given at (*i*). A dome should always be present to cause the weld to start at a point and increase progressively in section. A shoulder behind the head is always handy to provide a bearing for the welding electrode. If studs are straight without this shoulder, then it is usually necessary to clamp the stud rigidly in an electrode. Sketch (*j*) is similar to (*i*), but is intended to represent heavier combinations. Merely doming a shaft end is not alone sufficient to butt-weld it successfully to another surface that is part of a heavy chilled section. An extremely high current density for a short time, such as might require an electronic control, is necessary to heat the heavier piece sufficiently to allow it to be welded and still not upset the shaft.

Sketch (*k*) shows an annular type of projection that is often put on screw-machine parts. Such a projection is also stamped into a pressed-steel part, such as in the case of the metal radio tube. It is suited mainly to the welding of light-gage materials. In heavier forms, it heats irregularly and is not as satisfactory as the dome type of projection. A series or shunt weld is illustrated at (*l*). In many cases, a shunt block would solve an assembly problem or make welding in an inaccessible place possible. It has the additional feature that two welds are made simultaneously.

BUTT AND FLASH WELDING

It is not always possible or desirable to fit metal parts together in such a manner as to present the overlapping fits or broad surface to the surface contacts that spot, seam, and projection welding require. Obvious cases would be the welding of rods, bars, forgings, and those sheet-metal or pressed-steel parts whose ultimate form cannot tolerate the disturbance in appearance that a lapped or prepared joint would cause. Here, advantage is taken of the fact that welding heat can be generated by the passage of current through the metal comprising the abutting surfaces of the objects. This heating occurs at the junction alone because it is here that the heavy flow of current meets its greatest resistance, a sort of electrical bottleneck condition. To increase this junction resistance, light pressure is provided, resulting in poor electrical contact. Generally, a still further aggravation to current path at junction is brought about by deliberately permitting metallic arcs to occur by separating the parts while current is flowing. This arcing or flashing serves two purposes; (*a*) it pronouncedly localizes heating to just that metal which it is necessary to have plastic, and (*b*) the arcing can be handled so as to burn away the first points of contact in an imperfectly butted joint, resulting finally in a continuous line of welding even though it might not have been possible to have provided perfect initial fits. Plastic metals in the butt-flash weld are forged together by applying an upsetting force through the parts themselves. Inasmuch as the extent of plastic metal is confined to practically only the surfaces of the abutting parts, a narrow and sharply defined upset results which in most cases can be readily trimmed off, leaving little to show where the weld occurred.

A few combinations of nonferrous or alloyed metals are handled better by not permitting flashing to occur. Slower soaking heat of the plain butt weld can be used to favor metallurgical considerations and also permit adjustment of the degree of heat in each of the materials by spacing of the clamps relative to the joint. High-carbon or tool-steel drills, when welded to low-carbon shanks, represent a case where differential heating control is obtained by the manner of clamping. Because of their short plastic range, copper and aluminum butt welds require a machine that will provide a constant pressure on the joint with means to permit the materials to upset together freely as they soften from heat. Special arrangements can be made for suitable welding cycles to accomplish welds between aluminum and copper and other dissimilar combinations.

Butt- and flash-welding equipment is essentially made up of suitable clamping dies to hold and provide contact to the parts, a low-potential high-current welding transformer, a switching arrangement to close and open the welding circuit, a rugged frame with slides or bearings to provide for motion of the moving platen, and a mechanical or hydraulic source of power to move the work parts together under suitable welding conditions. Bars, rods, or compact sectioned pieces are readily handled on the many sizes of standard-design machine. Practicability of making long flash welds on irregularly shaped sheet-metal parts, in some cases exceeding 100 lin in., has been demonstrated in recent years and has opened an extensive field for this class of work. This equipment by nature requires special designs. In general, flash welders are made fully automatic.

CONCLUSION

In conclusion, the following suggestions are offered:

(1) For the present, take advantage of the consultation services offered by the larger builders of resistance welders. It is an exception nowadays when a welding problem is rejected as impossible of accomplishment.

(2) Investigate the newer alloys for welder dies.

(3) Try to incorporate the more dependable welding preparations into the parts, reducing the skill required of operator.

(4) Consider possibilities of welding two assemblies at one time or application of dial feeds to automatic welders.

(5) Look upon the welding machine as a machine-tool investment and procure versatile automatic types, avoiding getting just enough of a machine to do some particular short-lived job.

Hydraulic Structures

(*Continued from page 132*)

the hydraulic problems involved, and references to the literature of the subject will provide means for further study.

Part X, covering 69 pages, deals with the subject of river engineering under the heads of: building materials and elements at river works; river structures; improvement of streams; flood control—with numerous subdivisions under these heads. As with other sections of the work, this part is profusely furnished with illustrative material showing German practice in this important branch of hydraulic engineering. The subject of river structures is especially well-illustrated with drawings of works for the protection of river banks, and for the control and limitation of river flow. As elsewhere, copious bibliographic references refer the reader to more extended treatments of special phases of the subject.

Part XI, covering 53 pages, deals with the subject of waterways engineering under the heads: waterway vessels and their propulsion; waterways; shiplocks and lifts; special structures; waterway harbors—with numerous subdivisions especially under the third division. The first division is naturally dealt with only briefly, but gives in tabular form extended data regarding 16 German canals and 4 typical German river boats. Chief emphasis is placed on the subjects of waterways and waterway structures which are copiously illustrated with drawings showing approved German practice in these phases of engineering work. As elsewhere, bibliographic references direct the reader to sources of more detailed treatment of special phases of the subject.

Comparison with the German original, here and there through the work, indicates a close and faithful translation. The use of literal equivalents in the two languages leads, sometimes, to somewhat unusual English forms, as, for example: "valley dams" and "wetting irrigation." However, the meaning is clear and gives a faithful rendering of the original. The translation as a whole appears to be an excellent piece of work.

Hot Pressing of Plywood

(*Continued from page 134*)

The quantity of water in a mastic glue is moderate and little evaporation occurs at low press temperature. A 6.25-lb spread of dry base required 16 lb of water per 1000 sq ft of single glue line. Ordinary dry veneer panels of correct moisture content require no conditioning after pressing. Up to the present, its use has been principally confined to fir panels with and without Philippine mahogany faces. What success will be attained on hardwoods remains to be seen.

These new mastics are a good example of what was emphasized at the start, that hot pressing of plywood is distinct from resin bonding and covers, many times, a much broader field than the latter. This factor must be taken into account in selecting equipment, whose value will be measured by the extent to which it can be utilized under a great variety of conditions and with a wide range of adhesive products.

The specific developments mentioned are only units in the major development of the hot-plate process as a whole. Visualizing three distinct entities, hot-press equipment, hot-press processes, and hot-plate adhesives is now necessary. In all these directions the plywood industry is advancing. Broadening of hot-plate activities must not be inferred, however, as operating at the expense of resin bonding. A resin bond has no rival in its own field. Competition lies between nonresinous adhesives utilized in the hot press and those used in cold gluing and between the processes themselves. Various grades of plywood, the many uses to which it is put, and diverse requirements in quality of bond will determine more and more the choice of adhesives and the methods of using them.

J. A. Lucas

FLAX *and* HEMP

From the Seed to the Loom

By GEORGE A. LOWRY

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THIS country imports practically all of its fibers except cotton. The Whitney gin, combined with improved spinning methods, enabled this country to produce cotton goods so far below the cost of linen that linen manufacture practically ceased in the United States. We cannot produce our fibers at less cost than can other farmers of the world. Aside from the higher cost of labor, we do not get as large production. For instance, Yugoslavia, which has the greatest fiber production per acre in Europe, recently had a yield of 883 lb. Comparable figures for other countries are Argentina, 749 lb; Egypt, 616 lb; and India, 393 lb; while the average yield in this country is 383 lb.

To meet world competition profitably, we must improve our methods all the way from the field to the loom. Flax is still pulled up by the roots, retted in a pond, dried in the sun, broken until the fibers separate from the wood, then spun, and finally bleached with lye from wood ashes, potash from burned seaweed, or lime. Improvements in tilling, planting, and harvesting mechanisms have materially helped the large farmers and, to a certain degree, the smaller ones, but the processes from the crop to the yarn are crude, wasteful, and injurious.

Some flax is now pulled by machine and retting hastened by using warm water in tanks. Spreading the straw to dry is still laborious work and, while a thousand patents have been issued for breakers and scrutchers, room for considerable improvement still remains. Spinning, while effective, is seven times more expensive for linen than for cotton, wool, or worsted, and the subsequent handlings are expensive and deleterious. As advances in the arts are not made by dwelling on their merits but rather on their demerits, I will now endeavor to show the present state of the art and where material improvement is possible.

While neither presuming nor attempting to instruct our agricultural experts, I wish to give our engineers who are not farmers an outline of fiber-flax production and the development of mechanisms for reducing the straw to fiber and making it into finished linen. If a strand of yarn from a piece of finished linen is unraveled, it will be found to be composed of fibers that are from $^{5}/_{8}$ to $1^{1}/_{2}$ in. long and approximately $^{1}/_{10,000}$ in. in diameter and look like cotton. Let us consider the mechanisms and processing used to reduce the fiber to this condition from its parent straw and compare these with more recent mechanisms and methods and compare the results attained by a new process at a fraction of the previous cost in time, labor, chemicals, and equipment. Real progress is always made from the complex to the simple.

CULTIVATION OF FLAX

Thorough knowledge of the soil and its vagaries can only be obtained by living on it through many successive rotations of crops and noting their effect on each other and the effect of different fertilizers. While the analysis of both plants and soils can be obtained, what particular chemical the microorganisms in the soil can best use to make the required plant food cannot be told. However, you can never be far wrong in using good old stable manure for it has a fine assortment of the necessary gases and bacteria. Belgium prefers cow manure for flax.

Contributed by the Process Industries Division and presented at the Agricultural Processing Meeting, New Brunswick, N. J., Feb. 26, 1937, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

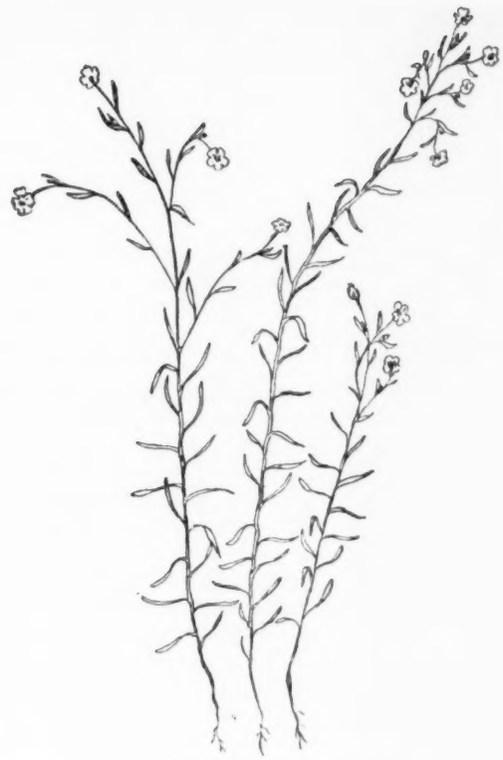

FIG. 1 FIBER FLAX

TABLE 1 AVERAGE YIELD PER ACRE FROM DIFFERENT SEEDS

Variety	Average scutched flax per acre, lb
Stormont Gossamer	731
Liral Crown	720
Stormont Cirrus	719
J. W. S.	613
Commercial (Riga)	467

Fiber flax (Fig. 1) has been grown almost everywhere between the frigid zones from upper Canada to South Africa and from the Atlantic to the Pacific but does best in temperate zones. An ample supply of moisture is the most essential requisite and early spring plantings are most likely to get it.

From the stubby taproot of fiber flax, many fine tendrils will go as deep in the ground as the plant is tall, provided the ground is sufficiently pulverized. Therefore, deep plowing and thorough breaking up of the soil is of the greatest importance in order that these tendrils may derive benefit from the moisture and gases from below, as well as taking other essentials down.

Much progress has been made in the last decade in developing new strains of fiber-flax seed to get better yields of straw, seed, and fiber. This was initiated by John W. Stewart, a North Ireland farmer, who, from many crops, selected the best specimens and kept planting the seed therefrom until he had what is now a standard seed, known to the trade as "J.W.S." From this, J. N. McBride of the Seaboard Air Line got a yield per acre of 6250 lb of dry straw, from which 1100 lb of fiber and $662^{1}/_{2}$ lb of seed were obtained, while the average yield from eight fields of ordinary flax was 3600 lb of straw and 476 lb of

FIG. 2 STALK OF FIBER FLAX SHOWING LAY OF THE FIBERS

seed. Since Stewart started this plan, many imitations have appeared and some improvement has been made, the most important strains and their yields on test plots being given in Table 1.

The seed should be planted uniformly, 1 in. deep, at the rate of about 90 lb to the acre, after which the land should be well-harrowed and packed by rolling. It does not follow by any means that the large straw will give a better yield of fiber per pound but it does give more per acre.

HARVESTING

Fiber flax should be harvested before it is too ripe or between 75 and 100 days after seeding. At that time, the bolls begin to turn from yellow to brown, the seeds are firm and turning from drab to brown, the leaves have mostly fallen, and the stalks are turning yellow. A self-rake reaper, which will cut the flax close to the ground and place the straw in windrows, will probably give best results. The straw may be left a day to dry but should be kept straight. It is then bound in small bundles of not more than 6 in. in diameter and set up in shocks. A self-binder may serve the purpose but does not cut as low as a self-rake reaper, and the branching flax plants do not work as well in the elevator and binder as wheat and oats. Flax straw is tougher to cut than wheat or oats and the cutting bar should have a more rapid motion with sharp, smooth-edged cutting sections. Hand pulling costs $12 to $15 per acre; machine pulling, $8 to $10 per acre; and a self-rake reaper, $0.50 to $1 per acre.

The principle on which the machine pullers work is not new and several of them are on the market, but they are still much too expensive for anyone but large growers or community ownership. They consist of pairs of vertical belts traveling in the same direction and with sufficient pressure against each other to pull the straw out of the ground and carry it along to an automatic binder. Flax has been pulled instead of cut because it was necessary to keep the end of the straw sealed when pool or river retting was carried on since cut straw allowed water to enter the inside of the straw, causing it to ret unevenly. The new tall strains of flax and some little improvement in cutting bars of self-rake or self-binder are the most likely solution of the harvesting situation, as hand pulling in this country is hardly to be considered.

Average height of flax straw is 40 in. but many of the new strains exceed that length. Roots contain no fiber and the seed ends, but little. Average-size retted straw, not having more than 10 per cent of moisture, has from 28 to 30 per cent of fiber. This yield of straight fiber is never attained by the scutching mechanism now in general use; in fact, more often it is only half of that. As the flax grows, it has from 20 to 30 leaves at intervals along its stem, and, at each of these, is a node where the fibers coming up from the root run out. Considerable fiber, therefore, does not run the full length of the stalk. The lay of the fiber on the stalks is shown in Fig. 2.

If fiber is whipped from the root end to the seed end, many of these fibers may not be removed, but if the stalk is held by the seed end and whipped to the root end, against the grain as it were, these shorter fibers will be stripped off. This is what every method in general use for scutching flax, whether it be by hand, scutching wheel, turbine, or hackle, does. When the straw is broken, the scutcher grips a handful by the seed end and subjects it to a whipping action by a blade of wood in his hand or by a revolving wheel with several blades. He then reverses the beating from the root end toward the seed end. The whipped-off fibers go with the shives and this has to be rescutched and reworked many times to get rid of the latter. However, all of the losses do not occur in this way. Full-length fibers are made up of short, laminated ones that are held together by gums and enough of this gum is beaten off in these handlings to loosen somewhat their hold on each other. As a consequence, by the time the flax reaches the spinning stage, it is much under its original dimensions.

RETTING AND DRYING

Two methods of retting are practiced. The effect of water retting is to lessen the adherence of the fiber to the stem but leaving the former with its full strength to resist the severe whipping that is necessary to separate it from the shives. When chemical retting, which is really degumming, is used, the adherence of the fibers to each other is lessened to such an extent that they cannot withstand the strenuous beating of the scutching operation, and the result is a conglomerate mass of short fibers and shives.

In water retting, the straw is subjected to sufficient moisture—either from dew, melting snow, or rain or by submerging it in ponds, rivers, or tanks—to cause fermentation. This and the bacteria that develop partially consume the gums connecting the fiber with the woody portion of the stalk. If retting continues too long it will also consume the fibers, so care must be taken to remove the straw at a time when wood and fiber will part easily. In Russia, the largest producer, most of the flax is dew-retted which is not as good a method as water retting.

In Fig. 3 is shown the latter method being used in Belgium, where from ten days to two weeks are required; while in Ireland, where the climate is colder, it may take from two to four weeks, depending on the temperature of the water. To hasten this operation, tanks with water heated to about 90 F and circulating slowly are used and the practice is increasing. Retting of the stalks make the shives or woody part only fit for burning. If unretted, they contain 7 per cent of proteins and 3 per cent of fat and are almost as good as some clovers for cattle food or may be made a portion thereof.

After retting, the straw is spread on the grass and turned several times to keep the color even. When nearly dry, handfuls are set up on their root ends, cone fashion, so the air may blow through, and, in the event of rain, shed it off. Air drying for all fibers is preferred to artificial heat. When the straw is fully dried, it is tied in sheaves and stacked. After it has gone through a sweat, it is considered in good condition to go to the scutch mill. This last treatment is called stack curing.

MECHANICAL AND CHEMICAL DEGUMMING OF FLAX FIBER

Like many important advances in the arts, this also came about by accident. The inventors, while exhibiting a new machine for cleaning retted flax, ran out of retted straw but had a sheaf of the unretted straw just as it came from the field with the seed on. With misgivings, they ran it through the machine, and, to their astonishment, it was not only perfectly deseeded but almost perfectly scutched. With time and per-

sistence and many rebuildings of machines, scutching also was satisfactorily accomplished.

Then came the difficulty; no market existed for unretted fiber, and linen men ridiculed the idea of degumming chemically. In addition to this there was the knowledge that, in spite of large premiums offered during the Civil War for those who could make flax spinnable on cotton-mill machinery, which was made idle by the embargo on cotton, no one had succeeded in doing it. However, it was "root, hog, or die," and many experiments were tried with vegetable oils, ethyls, and alkalies at varying temperatures. Some were encouraging, but costs and results had to be kept in mind, and, out of all these, caustic soda was found cheapest and best and most easily recovered after using.

Treatment of flax can be varied considerably according to the character of the product desired and the uses to which it may be put. On one hand, we may wish to obtain a product for spinning on regular linen machinery, and, on the other, we may wish to make a fiber that will spin on cotton or woolen machinery, which will require a modified treatment. In the first case, crude fiber obtained by mechanical treatment of the straw and thus freed from over 80 per cent of the nonfibrous material originally contained may be subjected to hot water under pressure in the absence of air, at a temperature that is preferably above the normal boiling point. This treatment effectually removes water-soluble constituents and gives a fiber which is much like that obtained by careful retting but superior in strength and uniformity to ordinary retted fiber. It should be hackled just as ordinary retted fiber is hackled after scutching, as hot-water digestion does not remove the shives.

Instead of hot water under pressure being used alone, some sodium carbonate may be employed and this greatly increases the solvent action of the water and a fiber is obtained that is as strong as, but is also superior in color to, the best retted fiber. The sodium-carbonate solution does not digest the shives completely but leaves a fiber that can be spun on linen machinery after hackling.

To digest flax shives completely, a stronger more-protracted treatment is required. For this, an 8 or 10 per cent caustic-soda solution that has been heated to 300 F or above is used under pressure in the absence of air. Although much of the nonfibrous matter is destroyed within approximately 1 hr, thorough digestion requires a treatment of 2 hr or more. Treatment for 3 hr or longer does not sensibly injure the cellulose fiber that constitutes 35 per cent of the shives, and, as this treatment removes the wax at the same time that it digests the shives, a fiber is obtained which has the proper "slip" to spin well on either cotton or woolen machinery.

Table 2 presents a comparison of the losses in the various steps from scutched fiber to bleached linen using mechanical and chemical degumming. This shows that the weight of bleached fabric available from a dry-straw weight of 27,880 lb is 1305 lb with mechanical degumming and 2691 lb with chemical degumming or approximately 2¼ times as much. In addition, the labor and manipulation in the chemical method are only one tenth of those in the old method.

TABLE 2 COMPARISON OF MECHANICAL AND CHEMICAL DEGUMMING

	Mechanical		Chemical	
	Lb	Per cent	Lb	Per cent
Dry-straw weight	27,880	100.00	27,880	100.00
Scutched fiber	2,683	9.62[b]	6,970	25.00[b]
Degumming loss	564	21.12	4,182	60.00
Spinning fiber	2,119	78.88	2,788	40.00
Loss in spinning	254[a]	11.99	70[c]	2.51
Spun yarn	1,865	88.01	2,718	97.49
Bleaching loss	560	30.03	27	9.93
Bleached fabric	1,305	4.68[b]	2,691	9.65[b]

[a] Flax-mill machinery was used for spinning.
[b] Based on dry-straw weight; other percentages are based on the weight of material available after preceding process was completed.
[c] Cotton-mill machinery was used for spinning.

For making high-grade linen paper, most of the shives should be removed in the digestion, thus necessitating less bleaching than is ordinarily required in making paper pulp. Obviously, products having properties that are intermediate to those described may be adequate for certain purposes and they can, of course, be prepared with ease by slight modifications along the lines indicated.

SCUTCHING

In Russia, Poland, and the other Baltic states, much of the straw was, and some still is, placed on a V-shaped trough and then forced into it by a V-shaped lever that is hinged at one end of the trough. Repeated moving of the straw at right angles across the trough and repeated driving down of the lever breaks up the woody part of the stalk and loosens it somewhat from the fiber. This partially broken straw is then taken in handfuls and held over the back of a chair or the end of the table or in front of the scutcher himself and whipped downward with a blade that is preferably made of some hardwood, such

FIG. 3 RETTING STRAW IN BELGIUM

as beech or ash. It is continually spread out fanwise to get at the interior stalks and is then reversed so both ends can be scutched.

With the advent of power, the first machines were designed, at the suggestion of an agricultural expert, for use by farmers to thresh and scutch their own straw in weather when they could not work outdoors. In the early machines, fluted rollers for breaking the straw were developed as well as the wooden blade that is mounted at right angles to a revolving shaft and is used to whip off the cracked-up shives. Some machines, instead of having blades on the revolving shaft, have them on revolving drums and the flax is carried across the face of the drum by belts that clamp the fiber. Others are set up in intermeshing pairs with curved blades like lawn mowers and the flax is conveyed between them. To get away from whipping the straw against the grain and also to lessen the work of the scutchers, many experiments have been made with different forms of flute in the breaking rollers, as well as increasing their number and giving them irregular revolution.

Flax straw is sensitive to weather or moisture conditions, and, while that can be allowed for in all hand or wheel scutching, it is not satisfactorily taken care of in the drum or automatic types. The drum type is called the turbine and was developed because, as time went on, the difficulty of getting skilled scutchers increased since the work is hard and objectionable from a health standpoint. Turbines also have a larger output than hand scutching. In Belgium, where they are frequently used, the flax receives a preliminary scutching with the turbine and is finished on the handwheel. Scutchers and farmers have one great objection to the machine; it cannot scutch flax under 30 in. in length. Therefore, the farmers are docked heavily for the short straw which is used for upholstery tow instead of for valuable line flax. The distance on each side from the clamp to the scutching blades and the width of the holding clamps are the cause of the trouble.

Another type consists of four slotted plates that have a reciprocating motion between five stationary slotted plates. Each revolution of the driving shaft bends and rubs the straw eight times. When the machine is running at 1000 rpm, the straw thus receives 8000 rubbings and bendings per minute. As the average speed of the straw through the farmer's machine is 24 ipm, each inch of straw is rubbed and bent approximately 28 times with a driving-shaft speed of 1000 rpm. To suit varying straw conditions, the extent of the bending and the pressure of the rubbing can be quickly adjusted.

To get a crosswise rubbing in addition to the reciprocating movement, machines have been built with movable blades mounted on opposing crankshafts. Later developments in the demand for cellulose-yielding products for wood flour and possibly for fodder have resulted in the construction of a larger machine for heavy duty and also to scutch hemp. Since flax is harvested before cotton is planted and the gins are idle during the summer, growers could handle flax in their idle gin plants the same as they do seed cotton. Efforts are now being made to perfect this arrangement.

To remove the shives from flax and the shards from hemp, each individual blade must be acted on by the cleaning mechanism throughout its length. Consequently, the depth of the mass or apron of straw fed into the machine will materially affect its cleaning action; for the thicker the bed, the more difficult it is to reach the interior straws, and the thinner it is, the more certainly will all the straws be operated on. Therefore, the operator, in feeding the machine, must use both hands to give the straw a certain flattening out, and the machine itself must have a spreading-out action. When the fiber to be scutched is held in clamps, it is, to a certain extent, bunched. This is so even in hand scutching, but the results in either case are still so unsatisfactory that the fiber has to go through many combings, some of the pins being as close as 50 per inch before it is fit for spinning.

ROUGHING, HACKLING, AND SPINNING

On reaching the spinning mill, the first operation is called "roughing." Its purpose is to straighten out and parallel the entangled fibers and remove shives, also to square the ends by breaking off the straggling fibers, and to break up the hanks of scutched flax into "cuts" for convenience in hand hackling and to fit the clamps on the hackling machine. The work consists in repeatedly drawing the flax through a coarse hackle fastened to a bench until the required condition is attained. In this operation, the flax is first grasped by the top or seed end and hackled toward the root end and then reversed.

The flax is then put on the hackling machine, which consists of six pairs of opposing endless traveling ladders, 3 ft wide, having rungs or crossbars that are studded with long, sharp pins, graduated in closeness from 4 per foot to 50 per inch. It is clamped to a conveyor by the seed end so that combing will begin at the root end which is hanging down between the traveling ladders, and, as the flax passes through the pins, the conveyor gives it a wavelike motion. Root ends are combed first and then the operation progresses gradually toward the clamps. The pieces are then automatically reversed so that the other end of the flax may receive the same treatment. As the result of these two operations, the hanks of flax are reduced to half of their size when received because, in combing the flax from the seed end, all fibers which do not reach that far are torn off and go into tow, also called "noils." What remains is known as line flax and is ready for spinning. Results of careful tests of straw from the dry unretted to the spinning condition are given in Table 3, which shows that the total fiber yield is less than 10 per cent of the dry-unretted-straw weight, and more than half of this fiber yield is tow.

TABLE 3 FIBER YIELD OF WATER-RETTED FIBER-FLAX STRAW

	Fiber		Tow		Total	
	Lb	Per cent	Lb	Per cent	Lb	Per cent
Dry weight before retting	....	.....	...	....	27,880	100.00
Dry weight after retting	....	.....	...	....	15,060	54.13[b]
Weight loss in retting	....	.....	...	....	12,820	45.87[b]
Yield when wheel-scutched	2,071	13.75[a]	612	4.06[a]	2,683	17.81[a]
Yield after roughing in spinning mill	1,979	7.10[b]	704	2.53[b]	2,683[d]	9.63[b]
Yield after hackling in spinning mill	1,202	4.31[b]	1,411[c]	5.06[b]	2,613[d]	9.37[b]

[a] Based on dry weight after retting.
[b] Based on dry weight before retting.
[c] Carded weight of tow yarn is 917 lb or 3.29 per cent of dry weight before retting.
[d] Difference between total weights after roughing and after hackling, 70 lb, represents lint and dust that was removed in the latter operation.

By the time the fiber is ready for spinning, more than 90 per cent of the original dry-straw weight has been lost. In the spinning operation, approximately 1 per cent more or 12 per cent of the usable-fiber weight is lost. Many attempts have been made to utilize unretted flax straw and get a usable fiber without these extraordinary losses in volume and expense. The plan tried was to reduce the straw to tow by running it through many pairs of fluted rollers and then card and spin the fiber. A large amount of money was spent trying to make a

good binder twine from seed-flax straw in this way. It was a single-strand twine and when the dew and rain touched it, retting commenced, the gums softened, the fibers slipped on each other, and the sheaves fell apart. Insects liked the taste so well that half of the sheaves would be cut and come apart in a single night. Fabrics made from unretted fiber-flax straw soon become sleazy because, when the gums disappear, the size of the yarn is smaller. When mixed with other yarns, they lasted longer but, when subjected to moisture, the odor was objectionable. Consequently, the plan was abandoned in this country and abroad.

BLEACHING

After spinning the flax and making linen, the next step is bleaching which removes gums representing between 30 and 33 per cent of the usable-fiber weight. Bleaching is really a chemical degumming process and the material receives drastic treatment. The Irish method of bleaching consists of 22 steps and reduces the strength of the unbleached linen by slightly more than 36 per cent.

The procedure for bleaching 1500 kg of material by the Irish method follows:

(1) Boil for 14 hr with 125 kg of lime.
(2) Wash for 40 min. in stocks.
(3) Steep for from 2 to 6 hr in $2^1/_2$ per cent (Twaddell) hydrochloric acid.
(4) Wash for 40 min in stocks.
(5) Boil for from 8 to 10 hr in 30 kg of caustic soda and 30 kg of rosin.
(6) Run off liquid and repeat boiling in caustic soda and rosin for 6 or 7 hr.
(7) Wash for 40 min in stocks.
(8) Grass for from 2 to 7 days.
(9) Steep for from 4 to 6 days in $^1/_2$ per cent (Twaddell) solution of chloride of lime.
(10) Wash for 40 min in stocks.
(11) Steep for between 2 and 3 hr in 1 per cent (Twaddell) sulphuric acid.
(12) Wash for 40 min in stocks.
(13) Boil for between 4 and 5 hr in caustic soda.
(14) Wash for 40 min in stocks.
(15) Grass for 2 or 3 days.
(16) Steep for between 4 and 5 hr in $^1/_4$ per cent (Twaddell) solution of chloride of lime.
(17) Wash for 40 min in stocks.
(18) Grass for from 2 to 4 days.
(19) Steep for from 2 to 4 hr in $^1/_8$ per cent (Twaddell) solution of chloride of lime.
(20) Wash for 40 min in stocks.
(21) Steep for between 2 and 3 hr in 1 per cent (Twaddell) sulphuric acid.
(22) Wash for 40 min in stocks.

If after going through the first 17 steps of the bleaching process the material is not sufficiently whitened, it is washed on the rubbing board with a strong solution of soft soap before completing the operation.

SEED FLAX

Seed flax is grown for the seed and is planted sparsely so it can branch out and have more seed-bearing ends. Since the straw has no market, long stubble is left in the ground. It is cut so high that the fiber left is not enough to justify the cost of scutching, and it has not been found profitable even for use in upholstery tow. The farmers call it their quick cash crop as it can be harvested in 90 days after planting and comes in far enough ahead of their other crops to take care of them financially. Quick threshing is, therefore, desirable and the machines used deseed 70 acres per day. Fiber from seed flax is good for cigarette and other linen papers. It is better than cotton linters for rayon and is also good for explosives.

The United States plants 2,500,000 acres of seed flax annually, Canada over 1,000,000, Argentina 5,000,000, and India 3,500,000. Practically all of this is burned except a small quantity that is fed to cattle in India and Russia. To prevent this great waste and give the farmers another source of income, a number have been interviewed and all declared their willingness to cultivate the soil so the binder could cut closer to the ground and to plant more heavily so the plants would grow taller and less branchy. It was pointed out to them that, while the average yield in the United States is only 6 bu per acre, fiber flax, which is planted 90 lb per acre, yields 10 to 15 bu per acre, thus giving not only enough additional seed to make the crop profitable but also straw that is profitable. The farmers said they would gladly try this plan if they could sell the crop as it stood and get cash. The farmer would harvest the crop for the buyer, who would take it when he wanted it. This sounds like a reasonable proposition for both farmer and purchaser.

It is imperative that the blades of straw be parallel to each other if they are to be cleanly scutched and a machine has been devised that will parallel the tangled, threshed straw. If the farmers will not accept the plan suggested—to plant closer, cut the stalks close to the ground, and then let the buyer thresh and scutch in one operation, as can be done now—then the straw can be put through the paralleler and scutched in the ordinary way.

HEMP PRODUCES LARGE CROPS WITH LITTLE ATTENTION

Hemp, the strongest of the vegetable fibers, gives the greatest production per acre and requires the least attention. It not only requires no weeding but also kills off all the weeds and leaves the soil in splendid condition for the following crop. This, irrespective of its own monetary value, makes it a desirable crop to grow. In climate and cultivation, its requisites are similar to flax and, like flax, should be harvested before it is too ripe. The best time is when the lower leaves on the stalk wither and the flowers shed their pollen. A view of hemp being harvested in Canada is presented in Fig. 4.

Like flax, the fibers run out where leaf stems are on the stalks and are made up of laminated fibers that are held together by pectose gums. When chemically treated like flax, hemp yields a beautiful fiber so closely resembling flax that a high-power microscope is needed to tell the difference and only then, because in hemp, some of the ends are split. Wetting a few strands of each fiber and holding them suspended will definitely identify the two because, upon drying, flax will be found to turn to the right or clockwise and hemp to the left or counterclockwise.

Before the war, Russia produced 400,000 tons of hemp, all of which is still hand-broken and hand-scutched. They now produce half that quantity and use most of it themselves, as also does Italy from whom we formerly had large importations. In this country, hemp, when planted 1 bu per acre, yields about 3 tons of dry straw per acre. From 15 to 20 per cent of this is fiber and 80 to 85 per cent is woody material. The rapidly growing market for cellulose and wood flour for plastics gives good reason to believe that this hitherto wasted material may prove sufficiently profitable to pay for the crop, leaving the cost of the fiber sufficiently low to compete with 500,000 tons of hard fiber now imported annually. Hemp being from two to three times as strong as any of the hard fibers, much less

weight is required to give the same yardage. For instance, sisal binder twine of 40 lb tensile strength runs 450 ft to the lb. A better twine made of hemp would run 1280 ft to the lb. Hemp is not subject to as many kinds of deterioration as are the tropical fibers and none of them lasts as long in either fresh or salt water.

While the theory, in the past, has been that straw should be cut when the pollen starts to fly, some of the best fiber handled by Minnesota hemp people was heavy with seed. This point should be proved as soon as possible by planting a few acres and then harvesting the first quarter when the pollen is flying, the second and third a week or ten days apart, and the last when the seed is fully matured. These four lots should be kept separate and scutched and processed separately to detect any difference in the quality and quantity of the fiber and seed.

Several types of machine are available in this country for harvesting hemp. One of these was brought out several years ago by the International Harvester Company. Recently, growers of hemp in the Middle West have rebuilt regular grain binders for this work. This rebuilding is not particularly expensive and the machines are reported to give satisfactory service.

Degumming of hemp is analogous to the treatment given flax. The shards probably offer slightly more resistance to digestion. On the other hand, they break down readily upon the completion of the digestion process. An excellent fiber can, therefore, be obtained from hemp also. Hemp, when treated by a known chemical process, can be spun on cotton, wool, and worsted machinery and has as much absorbence and wearing quality as linen.

SCUTCHING MACHINERY

Several types of machine for scutching the hemp stalks are also on the market. Scutch mills formerly operating in Illinois and Wisconsin used the system that consisted of a set of eight pairs of fluted rollers, through which the dried straw was passed to break up the woody portion. From there, the fiber with adhering shards or hurds, as they are called, was transferred by an operator to an endless-chain conveyor. This carries the fiber past two revolving single drums in tandem or between two opposing pairs of drums in tandem, all having beating blades on their periphery, which beat off most of the hurds as well as the fibers that do not run the full length of the stalks. The proportion of line fiber to tow is 50 per cent each. Tow or short tangled fiber then goes to a vibrating cleaner that shakes out some of the hurds.

In Minnesota and Illinois, another type has been tried out. This machine consists of a feeding table upon which the stalks are placed horizontally. Conveyor chains carry the stalks along until they are grasped by a clamping chain that grips them and carries them through half of the machine. A pair of intermeshing lawn-mower type beaters are placed at a 45-deg angle to the feeding chain and break the hemp stalks over the sharp edge of a steel plate, the object being to break the woody portion of the straw and whip the hurds from the fiber. On the other side and slightly beyond the first set of lawn-mower beaters is another set, which is placed 90 deg from the first pair and breaks the other end of the straw over a similar sharp-edged steel plate and whips out the hurds. The first clamping chain transfers the stalks to another to scutch the fiber that was under the clamp at the beginning. Unfortunately, this type of scutcher makes even more tow than the so-called Wisconsin type. This tow is difficult to reclean because the hurds are broken into long slivers that tenaciously adhere to the fiber.

Another type passes the stalks through a series of graduated fluted rollers. This breaks up the woody portion into hurds about $^3/_8$ in. long and the fiber then passes on through a series of reciprocating slotted plates working between stationary slotted plates. Adhering hurds are removed from the fiber which continues on a conveyor to the baling press. Because no beating of the fiber against the grain occurs, this type of scutcher makes only line fiber. This is then processed by the same methods as were described for flax.

Paint and lacquer manufacturers are interested in hempseed oil which is a good drying agent. When markets have been developed for the products now being wasted, seed and hurds, hemp will prove, both for the farmer and the public, the most profitable and desirable crop that can be grown and one that can make American mills independent of importations.

Recent floods and dust storms have given warnings against the destruction of timber. Possibly, the hitherto waste products of flax and hemp may yet meet a good part of that need, especially in the plastic field which is growing by leaps and bounds.

FIG. 4 HARVESTING HEMP IN CANADA

The SOCIAL SCIENCES *and* ENGINEERING EDUCATION

By WILLIAM E. WICKENDEN

CASE SCHOOL OF APPLIED SCIENCE

AN ENGINEER is a man who spends his life in solving problems. These problems assume an infinite variety of form and detail, but always end in two questions—"Will it work?" and "Will it pay?" The scale of the solution or judgment demanded in an engineering problem is never universal and seldom widely embracing. What the man in the head office wants to know is not "Will it always work?" or "Will everybody profit?" but rather "Will it work within stated limits or under particular circumstances?" and "Will it pay the investor within a given time?" For results beyond fixed limits the engineer is not held to account, but within them he is expected to be virtually right every time. Speculative inquiry and the formulation of broad judgments from loose masses of data, he willingly leaves to others, contenting himself with limited knowledge of assured character. The business world expects an engineer to know certain elemental things about the law of contracts, but when he gets into an involved situation he is expected to consult legal counsel. In much the same way, the engineer is expected as a matter of course to know certain fundamental facts and principles of economics, government, sociology, and psychology, but a wise instinct prompts him to defer to expert knowledge where involved issues are concerned.

In this introductory statement, I have attempted to reduce the engineer's hard-headed philosophy to thumb-nail dimensions. Admittedly, it is not a satisfactory philosophy. It may satisfy the individual engineer in his day-to-day work, but it does not satisfy a profession increasingly proud of its achievements and aware of their revolutionary social results. Engineers do not like to think that the world has been transformed in the last century and a half merely as a by-product of their success in solving a long series of specific problems; that civilization has become what it is merely because Watt invented a condensing engine, Bessemer a cheap way to make steel, Goodyear a way of toughening rubber, Taylor a scientific way to shovel ore, De Forest a three-element electronic valve, and so on *ad infinitum*. The idea of merely casual progress is too fatalistic. Like other men, engineers would prefer to discern some guiding principle—some thread running through the separate beads of technical achievement—which would reassure them as to the reality of progress. What is more, they would like to think that they have consciously had a part in threading the string through the beads, and should of rights have more say in the future what is to be done with the beads.

Nor does the thumb-nail statement of a hard-headed philosophy satisfy the leaders of society outside of the profession. President Roosevelt, inspired by his adventures in social planning and his crusades against the power industry, admonished the educators of engineers a little over a year ago as follows:

Events of recent years have brought into clearer perspective the social responsibility of engineering.

In respect to the wise use of natural resources such reports as those of the Mississippi Valley Committee, the National Resources Committee, and the Great Plains Drought Area Committee have brought out the facts impressively. The enclosed report, "Little Waters," presents in miniature many of the social-engineering problems of soil and water conservation.

In respect of the impact of science and engineering upon human life—social and economic dislocations as well as advance in productive power—the facts are revealed with distressing clearness in public records of unemployment, bankruptcies, and relief. The responsibility of scientists has been analyzed in noteworthy addresses such as, among the most recent, those presented at the Tercentenary Celebration of Harvard University, and the meetings of the British Association for the Advancement of Science.

The design and construction of specific civil-engineering works or of instruments for production represent only one part of the responsibility of engineering. It must also consider social processes and problems, and must cooperate in designing accommodating mechanisms to absorb the shocks of the impact of science.

This raises the question whether the curricula of engineering schools are so balanced as to give coming generations of engineers the vision and flexible technical capacity necessary to meet the full range of engineering responsibility.

I am calling this matter to the attention of educators of high administrative authority in the hope that it may be thoroughly explored in faculty discussions and in meetings of engineering, educational, and other pertinent professional associations.

Our Secretary of Agriculture, Mr. Wallace, who is rated by observers as the most reflective thinker among the President's close advisors, has stated the problem of the engineer's capacity in matters of general social import in more direct terms:

> There is something about engineering that tends to lay emphasis on logical, cold, hard, lifeless facts. Nearly all engineers have suffered the common punishment resulting from the remorseless discipline of higher mathematics, physics, and mechanics. . . . As a result, the engineer sometimes imputes a value to precise mathematical reasoning that it does not always have. There is such a thing as life, and the mathematics of life is as far beyond the calculus as the calculus is beyond arithmetic. . . . It seems to me that the emphasis of both engineering and science in the future must be shifted more and more toward the sympathetic understanding of the complexities of life, as contrasted with the simple mathematical, mechanical understanding of material production.

The engineer may be likened to a man who has lived a very busy objective life, a hard-working extrovert who has at last achieved a considerable degree of success and prominence. The time seems to have come for him to broaden out. He pauses to look about him and discovers that the people who seem to be running things are different from himself. They tell him "You may be a big butter-and-egg man, but there are a lot of things you lack. You're a sort of Philistine, you know; hard-headed and all that; short on culture; short on emotional sensitivity; short on human understanding; a good man to help pay the bills, but hardly one to run the party." The net result of his aspirations is something of an inferiority complex. If he happens to fall into wise hands, he learns that troubles with per-

Address of retiring chairman, Section M (Engineering) of the American Association for the Advancement of Science, Indianapolis, Ind., Dec. 29, 1937. Slightly abridged.

sonalities, as with nerves, are not often cured; instead, they are "adjusted." Getting adjusted means taking stock of one's limitations calmly and coming to terms with them. Limitations of nature one must accept without bitterness or envy, recognizing that most men have the defects of their virtues. Limitations resulting merely from education or experience one may strive hopefully to overcome, and especially not to repeat the errors of his own rearing in the children who are to come after him.

In this spirit let us, as engineers, look at ourselves. We recognize at the start that we have certain characteristic limitations which are apparently in our natures, otherwise we might never have become engineers. We love achievement, not speculation; we crave certainties, but shun subtleties; we are at home with precise and rigorous laws, but grow ill at ease when dealing with relations of vague and uncertain character; we value objective results over the ability to sway masses of men; we find matters congenial where the possibility of rational agreement is taken for granted; with the logic of mathematics and physics we feel at home, whereas the logic of judicial sifting of conflicts in evidence seems alien to us; we understand and practice the art of compromise where costs and values are involved, but not where political interests and emotions are in conflict. We make good administrators but poor politicians. We take command where problems in production and short-range economy are involved, but yield to others when long-time and involved questions of policy are to be dealt with. We are men who walk by sight, guided by evidence and logic; but we cannot trust ourselves to walk by insight, guided by feeling and intuition. A fairly close observer has recently characterized President Roosevelt as "an artist in political emotions rather than an engineer in economic facts." I scarcely need to point out that this is a comment on us, as well as upon him.

TENDENCY TO DELIBERATION CHARACTERISTIC OF ENGINEERS

To what degree we are what we are by nature or by nurture, must be left to psychologists to decide. "Born that way" is a partial answer at best, and not a valid alibi for habits engendered by education and experience. The engineer's habit of forthrightness goes well in a world governed by the Biblical injunction, "Let your conversation be 'Yea, yea and nay, nay'," but it tends to bar him from the world of adroit politics and suave diplomacy. His instinct for safety, his desire to be right in every case, breed a habit of deliberation, of witholding decisions until all available evidence is in, which may prove a handicap in executive positions where the risks of decision must be taken with scant deliberation. His impersonal modes of thought tempt him to think of workers and consumers as means to material ends, rather than as personalities having tastes, interests, feelings, and foibles to be regarded, so that when he does venture among the subtleties of human nature he risks seeming callow and naive.

That the foregoing characteristics can be modified by education can scarcely be denied. When the engineering graduate enters a law school, he has a difficult time adjusting himself to new forms of thought and logic. He usually overcomes the difficulty and becomes a competent lawyer, but then he is no longer an engineer. The question whether it would be possible through selection and training to alter the engineer's characteristics, especially as they affect men and society, and still leave him a competent engineer, is not so easily disposed of.

In the realm of industry two groups of problems are encountered, one to be approached through the physical sciences and the other through the social sciences. One path is well worn; the other is scarcely more than a faint trail. Through long years of association the engineer and the physical scientist have worked out a fruitful and fairly harmonious division of labor. The engineer's association with the social scientist is far less mature and effective. How far can these two go in setting up a working partnership?

The engineer's partnership with the physical scientist works because of the mutual recognition of distinctive functions. The scientist recognizes that no matter how extensive the engineer's scientific knowledge may be, science is to the latter essentially a tool, a means to certain clearly visualized ends, and not an end in itself. It is said that the engineering laboratories of one of the chief groups in the motor-car industry are run by the slogan, "Where science must work, or quit!" Hard boiled? Yes, but a perfectly proper slogan for an engineering laboratory. What is engineering but a search for the best answer to a limited problem that can be had for a limited expenditure of time and money? If all laboratories were run by that slogan, engineering progress would soon begin to slow down, then halt entirely. Engineering research pays dividends and they are soon realized, but over the decades and the centuries the richest returns come from the gratuitous and disinterested researches in pure science and knowledge sought for its own sake alone. The goal of the engineer is tangible results, the best to be had for a given cost. To the scientist, all truth has ultimate worth and all search for it an inherent validity transcending any economic criteria.

CONTRAST BETWEEN OLD AND NEW TECHNIQUES

As the old-time conflict between science and horse sense in engineering has abated, engineers and researchers have worked out together a new and greatly speeded technique of progress. The old rule was first crude invention, then practical adaptation, afterward—and usually long afterward—research on fundamental principles, followed by a battle to get scientific findings accepted and adopted, and finally the perfecting of traditional practices. Men invented glass, pottery, and brick at the dawn of civilization, but ceramic engineering has newly come among us. Tubal Cain, the legendary forger of metals, was of the seventh generation after Adam, but the science of metals is the work of our own generation.

The contrast between the new and the old technique of engineering progress is well exemplified in the story of the steam engine and that of radio transmission. Newcomen, you will recall, built the first workable piston engine in 1705. Nearly sixty years later Watt improved it by adding a separate condenser. Another sixty years elapsed before scientific men began to take serious interest in the engine, when Carnot published his remarkable analysis to prove that heat does work only by letting down from a higher to a lower temperature. But Carnot took no account of the heat which disappears in the process, for it was not until twenty years later that Joule established the doctrine of the conservation of energy. A science of thermodynamics scarcely existed before 1850 and its practical results were virtually nil before Rankine's attempts to set up a systematic treatment of steam-engine theory in 1859. One hundred and fifty-four years from invention to analysis, and then the battle for efficiency had only fairly begun.

How different is the story of wireless communication—Maxwell propounding on purely logical grounds his theory of electrical waves in 1865, Hertz producing the waves experimentally in 1888, Marconi applying them to wireless telegraphy in 1895, Thompson and Richardson investigating the conduction of electricity through gases in the 1880's, Elster demonstrating the principle of the two-element electronic valve in 1889, Fleming applying it to radio telegraphy in 1904, and De Forest producing the vital three-element audion valve in 1907, a series of logical steps from research to application paving the way for the swift

development of perhaps the most remarkable new art in all civilized history. As the philosopher Whitehead has so sagely remarked, the most important invention of the nineteenth century was the invention of the method of invention.

Science can live without technology, but its resources are immensely enriched and its activities stimulated by the union of the two. Technology, however, can scarcely exist without the fertilizing principle of science. Technological education dissociated from vital research in the basic sciences quickly grows sterile and routine. The intersection of research and economic application has accordingly come to be the major focus of engineering education. Is it possible to fix a second focus at the point of conjunction of technology and social science?

The foregoing question by its metaphorical form suggests that the social sciences have a functional and not merely a cultural relation to engineering education. "Functional" is probably as strong a word as we are justified in using. Few would suggest that social science is as yet sufficiently advanced to play an "instrumental" part, that is to supply either tools of analysis or criteria of decision for use in solving actual engineering problems. One hestitates to bring the word "cultural" into a discussion of this character, due to its almost universal loose interpretation. Probably no field of study is inherently cultural; music, literature, history, or philosophy may be either cultural or technical, according to the aim of the student and the method of the teacher. The same, I believe, may be said equally of mathematics, chemistry, mechanics, or even thermodynamics. At any rate, no inherent conflict exists between the professional utility of any subject and its function as a matter of general education.

SOCIAL STUDIES NOT REGARDED AS ACTUAL SCIENCES

Since technology cannot live without the physical sciences, the mathematician, the physicist, the chemist, and increasingly the biologist are all indispensable to the engineer as team-mates, but he has found no similar bond of necessity with the several groups of social scientists. He is likely to feel unsure that the social studies are actually sciences, as yet. One prominent engineer, noting the marked capacity of social scientists for disagreement among themselves, remarked that if they were all laid end to end, they would never come to a conclusion. The evolution of a science seems to exhibit three characteristic stages. First is the stage where an emerging science is able to explain events by cause and effect after they have occurred. The second stage arrives when science is able to predict events from their antecedents, and the third stage when science is able to control these results with a fair degree of certainty. The social sciences are attempts to deal rationally with the dynamics of human nature, with an interplay of simultaneous variables so numerous as to defy mathematical analysis and with little possibility of controlled experimentation. Wholesale assumptions and simplifications are necessary to make the variables manageable for logical purposes, and the so-called laws are broad generalizations, valid in only a qualitative, or at best a statistical, sense. They are seldom of more help to an engineer faced with a concrete problem than are the life-expectancy tables of an insurance company in the hands of a doctor with a sick patient.

When the engineer faces the question, "Will it work?" he turns to the physical sciences for his data and his tools. When he faces the question, "Will it pay?" he seldom turns to the more general of the social sciences, but rather to the very concrete science of accountancy. Any appeal to economics, sociology, political science, or social psychology is likely to be at the subconscious level. This appeal is not for tools, but for premises, especially the pre-suppositions of the man higher up who sets the engineer at his problem and reserves final judgment on his recommendations. Actual team work between engineers and social scientists on this basis can scarcely be expected to develop into any such intimate collaboration as that between engineers and physical scientists. Government boards and commissions may bring the two together to an increasing degree and more rarely the general staff of some vast industry.

EDUCATING THE ENGINEER IN THE SOCIAL SCIENCES

What the engineer learns of social science, it seems, will be chiefly through discipleship rather than team work. If this is limited to one or two hurried courses in college, as is so often the case at present, relatively small gains in understanding are to be hoped for. Students who give their major effort to social science as undergraduates seldom leave college with well-organized ideas, and their professors are not always noted for special aptitude in dealing with practical situations. Teachers of engineering, I fear, take a rather unholy pleasure over the economist who is habitually on the wrong side of the stock market, or the sociologist who offers the bank his personal check to cover an overdraft, or the psychologist who is not particularly successful in the rearing of his children. Foundations for understanding can be laid in college, but the problem is primarily one of adult education.

This suggestion that the engineer must seek his education in the social sciences in his adult years is not meant to belittle but to magnify the importance of the premises of practical action which men draw from social laws and doctrines. We live in a world in the grip of ideologies—Marxist, Fascist, New Deal, and conservative. The engineer is not immune, merely because his problems are limited in time and space, in scope and effect. Pass in review the major social changes of recent decades and not one will be found to be without fairly direct influence on engineering decisions—the disappearance of a geographical frontier, the decline of agriculture and of rural living, the growing dominance of industry, the gradual stabilization of population, the numerical increase of the older age groups, the growth of cities and their centrifugal spread into semiurban areas, the rise of taxes accompanying the rise in the proportion of wealth and income socially shared, the spread of secondary and higher education, the end of free immigration, the end of our traditional labor shortage, the rising importance of obsolescence of products or equipment, the development of research as a competitive weapon, the rising concentration of wealth in rapidly depreciating plant rather than in land of stable or rising value, the visible depletion of virgin resources, the universality of communication, the integration of industry under vast corporations, the growth of economic nationalism, and so on through the entire kaleidoscopic range. Engineers facing the risks of investment in new plant and replacements have a whole battery of new variables to reckon with.

We have more wealth than our fathers, but less security. George Washington was the richest American of his generation, as Henry Ford is reputed to be today. Is Ford the happier man? The Washington fortune, like most of the wealth of his day, was in land. With due allowance for changing weather, prices, and skill, the productivity of land was fairly constant. It had a stable value which could be expressed like other values in terms of a single commodity such as gold with fair trustworthiness. Land could be left idle for a decade with only nominal care and suffer little or no deterioration in productive capacity or in value. As time went on and population increased, land values were certain to rise in proportion. Henry Ford's fortune, like most of today's wealth, is not in land but in physical plant. Except for a nominal scrap value, its worth is solely a

matter of productivity. It may be worth a king's ransom today and nothing tomorrow. Keep it idle for five years and its value is all but destroyed. A strike may paralyze it without a moment's warning. Land has permanence, but plant is ephemeral. The values represented by imposing buildings and their equipment are mere transients, almost illusory, just the objectified forms of human ideas and ingenuity, the most changeable things we know. Over all our industrial wealth, and our personal jobs and fortunes as well, hovers the spectre of obsolescence—not the slow and orderly wear and tear of daily use, but the threat of some new product of the inventor's ingenuity, some new stroke of the stylist's brush, some new whim of the consumer's caprice. Long as we may for a life of ordered security, whose passing was lately lamented by Herbert Hoover, we shall find it hard to recover.

Behind all other social issues looms the overshadowing struggle, now world-wide, between collective security and free enterprise. Will the state, seeking to give its people security against foes without and economic hazards within, destroy the principle of individual freedom and initiative or so restrict it as to sap its vitality? As matters stand with us today, no one can give a confident answer to that question, but the present outlook is far from reassuring.

INCREASING SOCIAL CONTROL IN ECONOMIC PROCESSES

The social changes which have been enumerated all seem to point inevitably to an increasing degree of social control in economic processes. According to the scriptural legend, civilization began at the gates of Eden when man, whether by curse or by choice, began to eat his bread in the sweat of his brow. For 10,000 years or more man has been waging the struggle for more bread with less sweat. Out of this sweat has come one simple truth—you can have more wealth only as you produce it. There is a notion abroad that science holds some magical powers which, if properly manipulated, would work like Aladdin's lamp; that the productive machinery of society is already complete and self-operating; that discovery and invention represent doubtful gains; that thrift and investment are outmoded; that we need only to supply consumers with purchasing power from some hidden source; and that only the perversity and greed of economic royalists stand between the ordinary man and the horn of plenty. Over against these seductive illusions stands the stark fact that in the peak years of the 1920's we did not produce, nor could we produce, enough to provide for the reasonable needs of our people.

If civilization has taught us anything at all, it is that we can get gain in production only as we master the laws of nature, embody our ideas in useful forms, save our surplus to invest in tools of production and of distribution, and set up organizations in which men can do effective work together. Discovery, invention, thrift, and organized enterprise—these are the driving forces of progress tested and proved as nothing else in all of man's economic experience. But driving forces are of little use unless they are restrained, guided, and lubricated. The energies of steam will be of use to us only when confined in a cylinder or in the blading of a turbine, held in their courses by closely fitted bearings and guides, and their way skillfully smoothed by oils and greases. By analogy, the driving forces of progress are of no avail without social and political institutions, but these are the casing and the frame of the engine; the driving forces of progress are useless without good human relations, and these are the lubricants of industry. But the cylinders and guides, the oil pumps and grease cups, never put an ounce of energy into the machinery. To keep vital the spirit of research, of invention, of thrift, and of enterprise, and not to allow zeal for social control to quench the fires of progress, is now the first concern of educator, engineer, and industrialist.

The issues between immediate reforms and long-range goals find no more striking example than in the present controversy over the electric-power industry. Policing the industry may cut a cent or two from the rate per kilowatthour, whereas research may someday save much more.

RESEARCH THE ROAD TO THE MORE ABUNDANT LIFE

The country stands in dire need of between six and ten millions of additional jobs. If our millions of idle are ever to be employed, it will be in jobs not yet created, in serving industries not yet organized, in applying scientific truth not yet discovered, in operating machinery not yet invented, in making products not yet developed, and in supplying needs of which the public are as yet scarcely aware. This is the road that leads to the more abundant life.

Mr. Roosevelt is probably justified in his doubts concerning the ability of our present forms of engineering education "to give coming generations of engineers the vision and flexible technical capacity necessary to meet the full range of engineering responsibility." The fault, I believe, is not so much with what is taught or left untaught in college, as with a scheme of education which ends too often at college doors. Foundations of social understanding should be laid in college, and are being laid far more widely and effectively than the President probably realized, but the ability to consider social processes and problems in the design and construction of engineering works or of instruments of production and to cooperate in designing mechanisms to absorb the shocks of the impact of science is the proper objective of a life-time of education.

The work of the engineering colleges has been an active subject for discussion in professional circles these last fifteen years, with splendid gains on both sides. The profession has advanced its standards both in order and in quality and has quickened its touch on the lives of young men. The schools have moved steadily toward a type of training which is both more liberal and more fundamental, with greatly increased opportunities for advanced specialization after graduation. The lines have been mapped for years of further progress in our leading colleges. May I suggest, in conclusion, that this fine zeal on the part of the profession now be transferred for a time to a new area, that of further education for the young engineer in the first ten years of his active career? It is here, I believe, that the battle of social mindedness is won or lost. The Engineers' Council for Professional Development, representing jointly seven national engineering bodies, has taken this period of the engineer's education as one of its principal concerns. The Council is an agency for stimulation and coordination and not an operating body. What it can accomplish must be done principally through existing professional and educational institutions. What the national engineering societies can accomplish will be largely through their local chapters and sections. What the colleges can contribute to further education after graduation will be largely on a local basis. With E.C.P.D. now organized to give impetus and guidance on a national scale, next steps in progress seem to lie in the establishment of effective local joint councils or committees on professional education and development.

In the goals for this period of education, a mature understanding of social and economic processes should have a prominent place. It should be our concern not only to make the engineer competent to design and build with an understanding of social consequences, and to do his part to develop shock-absorbing mechanisms to ease the impact of technological change, but also to raise his voice in defense of sound economic and social policies which have stood the fire of experience.

ECONOMIC PLANNING *and* INTERNATIONAL ORDER

By HILLARY J. FISHER

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IN HIS BOOK[1] Professor Robbins states his object to be "to discuss from an international point of view the economic significance of various types of planning."[2]

The argument running through all of his discussion is the thesis of comparative advantage: A given country, hence the world as a whole, gains most by directing its resources and productive activities into those channels in which it has the greatest comparative advantage or the least comparative disadvantage. This is the principal criterion used to judge the various forms of planning.

For convenience, types of planning are classified under "independent national planning," "partial international planning," and "complete international planning." Independent national planning includes both partial planning, such as controlling the movement of goods, capital, money, and people through protective tariffs, control and direction of investment, exchange manipulation, and immigration laws, and complete planning in the form of national socialism or state syndicalism. Under partial international planning, the author discusses trade agreements, international planning of particular lines of industry, as by cartels, and international regulation of wages and hours of labor. Finally, he comes to international communism and international liberalism.

All types of planning, except international liberalism, are rejected because they involve restrictions which hinder maximum utilization of resources. Tariffs permit industries to grow beyond the point where they are economically justifiable, and force other resources into less productive uses, while retaliation ultimately offsets any gains to a nation resulting from such restriction. Control of investment prevents free flow of capital into those uses and those places where it would do the most good. Exchange manipulation and export bans on gold prevent movement of money to places where credit is most needed. Likewise restriction of migration hinders the optimum utilization of labor resources as a whole.

However, "it is not impossible," Professor Robbins says, "to conceive of cases where, by the limitation of immigration, the inhabitants of rich but relatively sparsely inhabited areas may secure to themselves gains which would not occur if movement in were not limited."[3] But, he continues:

> It may be advantageous to be able to exclude emigrants from areas for whose products demand has contracted. But it may also be advantageous to be able to migrate elsewhere when demand for one's own products diminishes. . . . There can be little doubt that, over long periods, most national groups would be better off if national limitations on migration were removed."[4]

But with free migration and other conditions as they are, nations that have restricted their populations would be quickly overrun by inhabitants of those countries where population pressure is great. If physical returns per labor unit are already decreasing, further decreases will mean a lower average real income, at least until capital equipment is increased sufficiently through savings, and productive techniques are improved. At any rate, the level of real income in a formerly restricted area, such as the United States, would be less for a considerable period of time.[5] Furthermore, friction due to racial antipathies would be heightened. And since no lessening of industrial fluctuation and unemployment is promised, competition for jobs would further increase racial conflicts. Under these conditions, how could the people of any country be persuaded to give up any present advantages they possess to improve the situation of a future generation?

Professor Robbins brings up the argument that, if our economic dams are not voluntarily removed, they will be destroyed through war. Any kind of political division of the world, whether democratic or dictatorial, capitalistic or socialistic, will result in each political unit trying to improve its own situation at the expense of others. War is the inevitable result, and attempts to achieve economic self-sufficiency on the part of each nation by various restrictions are a natural consequence of the possibility of war.

> If the various national states would organize their affairs on a basis of economic self-sufficiency, it is said, the dangers of war due to economic causes would be minimized.[6]

But

> given the present political divisions of the world, to recommend autarky as a general policy is to recommend war as an instrument for making autarky possible.[7] . . . For, so long as the inhabitants of the different states were prevented from bettering their position by exchange or by migration, some self-sufficient states would be richer than others. It would always be possible to hope that things would be improved by a forcible enlargement of frontiers. The population of the East will be increasing long after the population of the West has become stationary or declining. If they are forcibly prevented from foreign trade, they are not likely to forget that, at no very distant date in the past, it was deemed justifiable to break down similar prohibitions on their part with cannons and bayonets."[8]

National planning on a selfish basis, then, is inefficient and leads to war. And national planning on a liberal basis is impossible because human beings are selfish; one or more political

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[1] "Economic Planning and International Order," by Lionel Robbins, The Macmillan Company, New York, N. Y., 1937.

[2] Ibid., p. 3.

[3] Ibid., p. 317.

[4] Ibid., p. 318.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[5] Professor Mather of Harvard University, a prominent geologist, has stated that the known natural resources of the world are sufficient to support about three billion persons at the present average American standard of living for a period of several thousand years. If it is possible to exploit these resources fully, limited natural resources are not yet an argument for nationalism.

[6] "Economic Planning and International Order," by Lionel Robbins, The Macmillan Company, New York, N. Y., 1937, p. 319.

[7] Ibid., p. 321.

[8] Ibid., p. 322.

units would seek to gain some advantage and so force the rest to do likewise. "But if the political organization is sectional, it may give rise to optical delusions, behind which the forces of violence and monopoly may manoeuvre."[9]

But what of partial international planning? Such planning is artificial and arbitrary, because it is determined through the bargainings of political representatives of the various nations; or, if it is on an industrial basis, monopolistic restrictions and maladjustments between industries result. Bargaining strength is the determining factor, not relative efficiency.

International communism is dismissed, not only because it is incompatible with democracy, but also because it provides no regulator of efficiency.

> If the productive operations which have to be planned are on an international scale. . .then it is safe to say that, if there is no market for the factors of production, there is no method of accurate costing available. And without accurate costing, an economical satisfaction of the wants of the citizens cannot be planned. . . .The consumption of the people adapts itself to the output of the plan, not the output of the plan to the consumption of the people.[10]

Professor Robbins then turns to "international liberalism" as the only permanent solution to the economic difficulties of the world. His contention is that "an international liberal plan is conceivable which is technically workable and which is free from the manifest contradictions of other forms of planning."[11]

By international liberalism is not meant an economic alliance of nations but a political federation as unified as the United States of America. A united world state is suggested.

> There is only one solution to this stupendous problem. The first need of the world is not economic but political revolution. It is not necessary that a world state should have powers unrestricted by constitution. But it is necessary that the national states should surrender certain rights to an international authority. The right of making war and the power to do so must be given up. But they need not give up all their rights of independent government, and the rights of the international authority must also be limited. There must be neither alliance nor complete unification, but Federation.[12]

No local restrictions on interregional trade or on movement of labor or capital would be permitted. Central and local governments would meet only those needs not suitable for private enterprise to meet. If governments did engage in business, "they should not be empowered to prevent private enterprise from competing with them, and. . .they should be subject to the same rules of fair competition as the others."[13]

Summarizing the operation of the liberal state, the author says:

> There must be security. There must be a legal framework appropriate to the effective working of the system of markets and private property. In various ways. . . .government machinery must provide supplements to the principles of private property and family responsibility. The citizens, as consumers, distribute their incomes between the different commodities according to their private preferences for themselves or for others. As producers, they sell their services and the use of their property in ways which they hope will bring the highest return compatible with their desire for security and private amenity. They are thus led, by the artificial institution of the market, into lines of production which serve their preferences as consumers.[14]

Since Professor Robbins' aim was "to show the implications of different types of principle, not to prepare a programme of immediate action,"[15] the reader naturally thinks of a number of questions which the author does not answer. Could the change to the new system be made gradually enough to prevent undue hardship on those with "vested interests?" Would one type of central government be satisfactory to those who have been brought up in a tradition of democracy as well as to those who have lived and breathed imperialism all their lives? How could a compromise be reached by the diverse peoples of the world on a constitution acceptable to all and at the same time workable and durable? How solve the problems of population quantity and quality which would surely arise? What nation would be humble enough to initiate the movement toward unification by offering to give up its essential powers to a world authority elected mainly by "foreigners?" Would not force be necessary to bring some parts of the world into the federation, or would economic pressure be sufficient? Would not the control of the world republic be such a tremendous prize as to cause incessant conspiracy and revolution? Can man progress so far in one step, or must he drift along in the conflicting current of events?

This political change would eliminate international friction, but not class friction. Private property would be essential to international liberalism, hence inequalities in individual incomes resulting from inequalities in the division of property would still exist. Professor Robbins minimizes this defect which remains by saying, "If private property were abolished, then other incomes would be lower. The toleration of inequality is surely a small price to pay for the reduction of poverty."[16] But does he not seek to abolish national property rights? National property rights, he contends, result in regional conflict. The "have-not" nations make war on the "have-some" nations. But do not individual property rights in land and productive equipment lead just as surely to class struggle? Are not the have-not classes lined up against the have-some classes? Or what did underlie the French Revolution, the Irish Rebellions, and the upheavals of the present century? And would not letting down the bars that now divide nations intensify rather than mitigate such class struggles?

The essay as a whole is interesting and readable. It is recommended to every person interested in the broader problems of the present day, for it is an excellent summary of a considerable body of economic thought. Moreover, its tone is rather inspiring, especially in the concluding paragraph:

> Nationalism is something which must be surpassed. . .There was probably never a moment in the history of the world when such a task seemed so difficult to accomplish. But it can be accomplished if our hearts and minds tell us that it is necessary; and it must be accomplished if all that we regard as most valuable is not to perish in the wreck of our common civilization.[17]

THE GROWTH of industries has created a demand for a wide range of men with various grades of engineering qualifications. Practically all the services that are characteristic of this age of invention and of discovery are dependent for their efficient direction on fully trained engineers. The strong pulse of our economic and social life would rapidly die away if their direction, for any cause or by any mischance, ceased to be available. Few in number, it is not too much to say that the trained engineers of a country are the trustees of its twentieth century civilization.—From presidential address of F. E. W. Hackett to Engineers' Association of Ireland, *The Engineer*, Dec. 31, 1937.

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[9] "Economic Planning and International Order," by Lionel Robbins, The Macmillan Company, New York, N. Y., 1937, pp. 326–327.
[10] Ibid., pp. 203–204.
[11] Ibid., p. 309.
[12] Ibid., p. 245.
[13] Ibid., p. 257.
[14] Ibid., p. 258.
[15] "Economic Planning and International Order," by Lionel Robbins, The Macmillan Company, New York, N. Y., 1937, p. viii.
[16] Ibid., p. 266.
[17] Ibid., p. 327.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Day by Day

SCIENCE stole the show during Christmas week, thanks to the Indianapolis meeting of the American Association for the Advancement of Science, its well-organized press service, and the active cooperation of the newspapers. Although engineering was a minor factor at Indianapolis, there was much in which engineers find interest. Further gleanings of newspapers and correspondence reveal the names of engineers mentioned in what follows:

Moss

Retirement on Jan. 1, 1938, of Sanford A. Moss, member A.S.M.E., after 35 years of service with the General Electric Co., provided the occasion for luncheons, farewell parties, and dinners in his honor on Dec. 21 and 22 at West Lynn and Salem, Mass., and Dayton, Ohio. Warm affection for Dr. Moss as a man and sincere admiration for him as an engineer, inventor, and scientist were expressed by many subordinates, fellow workers, and executives who attended these functions.

At the River Works of the General Electric Co., West Lynn, the farewell party took the form of a luncheon tendered by Dr. Moss's associates in the supercharger department. Airplanes flying over the works dropped messages attached to tiny parachutes, and a wardrobe suitcase was presented to him by his former associates. At the close of the luncheon Dr. Moss was "arrested" and taken to another farewell party in the turbine works where he was "tried" for various "crimes."

The dinner at the Hotel Hawthorne, Salem, at which 57 G. E. executives and guests were present, was held on Dec. 21, 1937. Here Dr. Moss was presented with a wrist watch and combination thermometer, barometer, and humidity indicator. In a life filled with successful applications of science to industry, Dr. Moss has learned that he can rely upon theory and hence has held to the belief that in the long run he cannot be a loser in games of chance. He is always eager to match coins with anyone game enough to try his luck and, in recognition of this engaging practice, twenty new quarters were turned over to Dr. Moss at the dinner. At the Hotel Van Cleve, Dayton, Ohio, on Dec. 22, Dr. Moss was guest of honor at another dinner which took the form of an informal reunion of Dr. Moss's old friends and associates in the early experiments with the supercharger.

Dr. Moss is probably best known today for his work in connection with the development of the supercharger for airplane engines. In spite of his close association with the aeronautic industry and his valuable contributions to flight at high altitudes, it is said that Dr. Moss has never been aloft. He was wont to excuse himself on the grounds that he could not get out and fix a supercharger in the air and hence was of no use in the plane. It is said that once when it seemed inevitable that he should make a flight he was saved by a telegram from the company laboratories ordering him not to go up. Some time later it was discovered that this order had been inspired by the wiley doctor himself.

This desire to keep his feet on the ground has not hindered Dr. Moss from making possible the flights of other men into higher and rarer atmospheres. He is credited with development of the substratospheric ship at Wright Field with its supercharged pressure cabin, and with the experimental TWA plane with which flying conditions in the higher altitudes are being investigated by D. W. Tomlinson.

In a recent letter Dr. Moss says: "I have alleged for years that I am an expert in pumps and flow of fluids. Yet I have not been able to keep my own blood-pumping apparatus in good order, and am therefore giving up all technical activities except the A.S.A. symbols work. I have been a member of the A.S.M.E. long enough to have a life membership but have resigned from all other societies and from all A.S.M.E. committees except the symbols ones. The G. E. gives me desk room and secretarial service for this work, and my address will be care G. E. Co., West Lynn, for it. On Jan. 1 my wife and I leave for Central America, returning to Lynn in April."

Painstaking, nervous, his eyes sparkling with fun or fury, Dr. Moss raises his pointed beard in his companion's face and looks at him through the lower lenses of his glasses. His tongue, trying to keep up with an agile mind, is ready for a persistent barrage of embarrassing questions or a volley of explanations. He possesses that disarming characteristic of small boys with whom it is impossible to be angry for long in spite of sometimes exasperating behavior. Once you have met him you never forget him, but think of him in terms of warm affection.

Dunn

Gano Dunn, member A.S.M.E., president of The J. G. White Engineering Corporation, of New York, for 24 years, has been awarded the 1937 Thomas A. Edison Medal of the American Institute of Electrical Engineers, highest honor in electrical engineering.

The award goes to Mr. Dunn, who is president of Cooper Union, "for distinguished contributions in extending the science and art of electrical engineering, in the development of great engineering works, and for inspiring leadership in the profession."

Author of more than thirty inventions in the design and construction of electrical machinery, Mr. Dunn, as chief executive of the White Engineering Corporation, has directed outstanding construction projects, including the great steam plant at Muscle Shoals now operated by the Tennessee Valley Authority; 13 transoceanic radio stations for the Radio Corporation of America, among which is the large station at Rocky Point, Long Island; the early government aviation

station at Langley Field, Virginia; several sulphur-extraction plants for the Texas Gulf Sulphur Company and the Freeport Sulphur Company near the Gulf of Mexico; the first long-distance natural-gas pipe line extending from the midway gas fields in California to Los Angeles; numerous oil refineries and particularly the great refinery of the Standard Oil Company of New Jersey at Port Jerome, near Havre, in France; three large irrigation dams for the Republic of Chile; five large dams for the Republic of Mexico; numerous large dams and hydro-electric developments in all parts of the United States as well as industrial and public-utility steam power plants and transmission lines; blocks of apartments at Jackson Heights, New York, and several modern hotels.

For Emperor Haile Selassie of Ethiopia and the British and Egyptian governments, the Corporation conducted two engineering expeditions into the central part of Ethiopia and was about to begin construction work on damming the Blue Nile at Lake Tsana to supply irrigation for the Anglo-Egyptian Sudan when the Italo-Ethiopian war broke out. Mr. Dunn is at present guiding the construction of a 20,000-kw steam power plant for the Royal Dutch Shell group for pumping the oil fields on the shores of Lake Maracaibo in Venezuela.

Mr. Dunn was first chairman of the Engineering Foundation, founded in 1914 by Ambrose Swasey. He was president of the United Engineering Societies from 1913 to 1916, of the American Institute of Electrical Engineers in 1911–1912, and of the New York Electrical Society from 1900 to 1902. He was chairman of the National Research Council of the National Academy of Sciences from 1923 to 1928.

Active in international scientific organizations, Mr. Dunn was vice-president of the International Electrical Congress of Turin in 1911, secretary for electric lighting and distribution of the International Electrical Congress of St. Louis in 1904, and official delegate of the U. S. Government to the Second Pan-American Scientific Congress in Washington in 1915, and the third Pan-American Commercial Conference in Washington in 1927. He is honorary vice-president of the Pan-American Society.

He was a member of the War Department Nitrate Commission from 1916 to 1918, and chairman and disbursing officer of a special committee of the State, War, and Navy Departments on Submarine Cables in 1918. He was also a member of the engineering committee of the Council of National Defense.

Mr. Dunn is chairman of the visiting committee of the Bureau of Standards, and honorary secretary for the United States of the British Institution of Electrical Engineers. He is fellow of the Royal Microscopical Society of London, the Institute of Radio Engineers, the New York Academy of Sciences, and the American Association for the Advancement of Science. He is honorary member of the Association of Iron and Steel Engineers, and member of the American Society of Civil Engineers, The American Society of Mechanical Engineers, The Franklin Institute, the Illuminating Engineering Society, the Optical Society of America, the Horological Institute, the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, and the New York Chamber of Commerce. He is a member of the executive committee of The Pilgrims.

He was appointed by President Roosevelt to the Science Advisory Board, and has been a member since its beginning of the Business Advisory Council for the Department of Commerce. In 1935 he became president of Cooper Union for the Advancement of Science and Art, succeeding the late R. Fulton Cutting. He had previously been a trustee of the Union. He is a trustee of Barnard College and a former trustee of Columbia University.

The Edison Medal, founded by associates and friends of Thomas A. Edison to perpetuate his memory and the memory of his great works, is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts" by a committee of twenty-seven of the leading members of the American Institute of Electrical Engineers.

Hedrick

According to *Science*, the American Mathematical Society has voted that the volume for 1938 of the *Bulletin* of the society be dedicated to Dr. E. R. Hedrick, vice-president of the University of California and provost of the university at Los Angeles, with the following inscription: "By order of the Council of the Society, this volume is dedicated to Earle Raymond Hedrick in appreciation of his services to the society as editor in chief of the *Bulletin* for the past seventeen years." Dr. Hedrick is a member of The American Society of Mechanical Engineers.

Mead

For his paper "Power Plant Trends," presented before the Royal Aeronautical Society in London on April 22, 1937, George J. Mead, member A.S.M.E. and vice-president of the United Aircraft Corporation, was awarded the Taylor Gold Medal on Dec. 17, 1937. This medal is given annually to the lecturer whose paper is judged by the council to be the best presented to the society during the year. A brief summary of the paper appears on page 63 of our January, 1938, issue.

Beau de Rochas

Among the names which writers on thermodynamics attach to heat-engine cycles—Carnot, Brayton, Rankine, Diesel, and the others—is that of Beau de Rochas, French inventor, who filed a patent, on Jan. 16, 1862, covering a four-stroke internal-combustion-engine cycle, generally known today as the "Otto cycle."

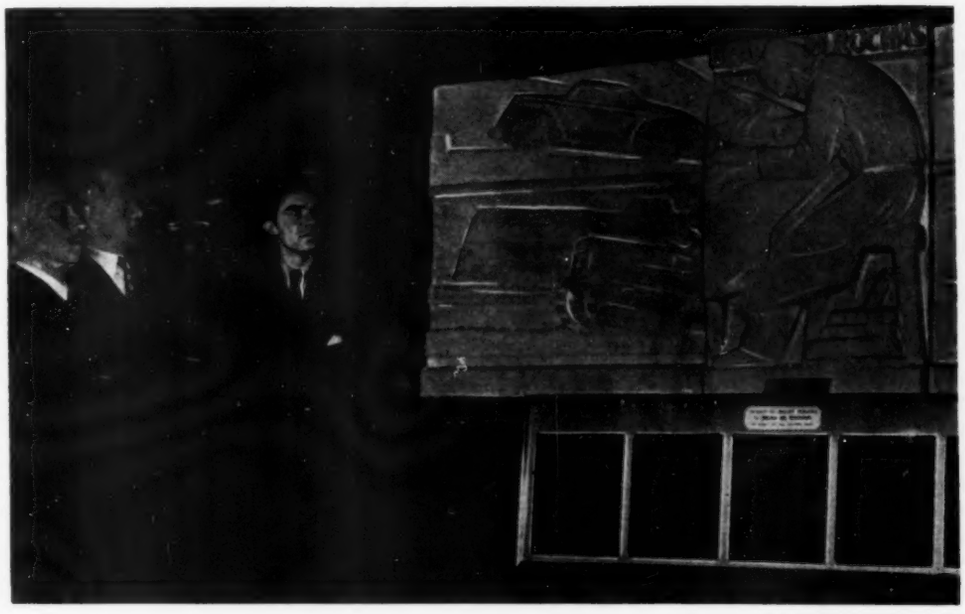
On Friday, Oct. 8, 1937, at the inauguration of the 1937 Paris Motor Show, a bas-relief executed by M. de Bus, at the instigation of the Société des Ingenieurs de l'Automobile, of France, was placed on view and was presented to the President of the French Republic, M. Lebrun, who is shown, in the accompanying illustration, standing before the tablet.

Through the courtesy of Pierre Prevost, president, and A. Boudineau, secretary, of the SIA, to whom we are indebted for the illustration, information concerning Beau de Rochas has been obtained.

The French inventor, Alphonse Eugene Beau de Rochas, was born, April 5, 1815, at Digne (Basses-Alpes), the son of an inspector of internal revenue, Alexandre François Beau.

According to a memorandum written in 1861 and published in Digne, signed Beau de Rochas, the writer was then a resident of Paris and was connected with the Compagnie des Chemins de fer du Midi, and recommended for consideration a railroad between Paris and Nice via Grenoble, Digne, and Annot.

In 1861 Beau de Rochas published a pamphlet on the theory of the four-stroke cycle entitled "New researches concerning the practical conditions for the utilization of heat and, in general, motive power. A general description of certain improvements to introduce into steam generators or gas engines." On January 16 of the following year he applied for a patent on an internal-combustion-engine cycle performed in four consecutive strokes: (1) suction during an entire stroke of the piston; (2) compression during the following stroke; (3) ignition at the dead-center position and expansion during the third stroke; and



AT 1937 PARIS MOTOR SHOW, PRESIDENT OF THE FRENCH REPUBLIC PAYS TRIBUTE TO BEAU DE ROCHAS, FRENCH ENGINEER, INVENTOR OF FOUR-STROKE CYCLE

(4) exhaust of the burned gas from the cylinder during the fourth and last stroke. He further advised that the compression be increased to the point of the spontaneous ignition of the gas-air mixture. Thus Beau de Rochas suggested an essential improvement in the Lenoir gas engine, the compression of a full cylinder of gas-air mixture, which increased materially thermal efficiency and reduced vastly the size of an engine of given output.

According to the minutes of a general meeting, May 22, 1891, of the Société d'Encouragement pour l'Industrie Nationale, "priority of the invention has not been contested. It has been established by the Courts in well-known decisions based on reports by prominent and reliable scientists. . . . .The patent for which he applied in January, 1862, was, without result, proposed to several engineering companies. The author was ahead of his time. He was not understood; and, since 1863, the patent has been public property. . . . . .Several years later the four-cycle engine appeared under other names and gave honor and fame to its promoters."

Beau de Rochas published researches of great interest in the field of hydraulics, railroad construction, steam navigation, and internal-combustion engines. He is said to have to his credit ingenious methods for the calculation of catenary cables, and to have applied his method in several cases, especially for submarine telegraphic cables and for the towing of boats in strong currents.

He died in May, 1891.

Sloan

On Dec. 13, 1937, Alfred P. Sloan, Jr., chairman, General Motors Corporation, announced a donation as an endowment to the Alfred P. Sloan Foundation in the form of securities having an estimated worth of $10,000,000. Emphasis was laid on the fact that the transaction had nothing to do with General Motors Corporation or with Mr. Sloan's official relationship to the corporation. Mr. Sloan's public statement read, in part, as follows:

As to the objectives: The Alfred P. Sloan Foundation has as its general purposes, in common with all such organizations, the advancement in any proper way of the interests of the community at large. While the scope of all such welfare activities is unlimited, this particular Foundation proposes to concentrate, to an important degree, on a single objective; i.e., the promotion of a wider knowledge of basic economic truths generally accepted as such by authorities of recognized standing and as demonstrated by experience, as well as a better understanding of economic problems in which we are today so greatly involved and as to which we are so importantly concerned.

While down through the years many successful men and women of America have contributed in the aggregate large sums for the benefit of those less fortunate, very little has been specifically directed toward the cause of economic education—undoubtedly due to the fact that the importance of that problem has only recently become generally recognized as one in which everyone is so individually concerned. While the Alfred P. Sloan Foundation may undertake or promote activities on its own behalf, it will give preference to encouraging, through financial grants and otherwise, such useful agencies as already exist, thus stimulating a broader approach to the common objective, although it might be added its activities will necessarily be limited to the areas of education and research.

Having been connected with industry during my entire life, it seems eminently proper that I should turn back, in part, the proceeds of that activity with the hope of promoting a broader as well as a better understanding of the economic principles and national policies which have characterized American enterprise down through the years, and as a result of which its truly marvelous development has been made possible. All this with the belief that its progress may not only be maintained but accelerated through a more constructive opportunity resulting from a more enlightened understanding on the part of more of our people. Thus, in the exercise of their rights, they may be better advised as to our national policies and, according to their beliefs, may promote the objectives that all have so much in mind—more things for more people, everywhere—an opportunity for achievement—and greater security and stability, as well.

$300,000

A gift of $300,000 from the Maurice and Laura Falk Foundation to the Carnegie Institute of Technology for the support of a program of education and research in social relations was announced on Dec. 9, 1937.

In recognition of Mr. Maurice Falk's lifelong interest in social problems, said the statement announcing the gift, the Foundation will establish at Tech a professorship of social relations, and the holder of this position will have charge of the new educational program at Carnegie. At the suggestion of the Carnegie Institute of Technology, the newly established chair will be known as the Maurice Falk Professorship of Social Relations.

The gift from the Falk Foundation will make it possible for Carnegie Tech to undertake two closely allied projects in its educational program, both of which are in keeping with the

objectives of the Foundation in solving problems involving economic and social relationships.

The first of these projects will have as its objective the development in the young engineer of a social consciousness and social responsibility. To attain this end there will be set up at Tech a program of related social and cultural studies in the College of Engineering to run throughout the four-year college period of attendance.

The second project will provide for a continuing, long-range research study of the ever-changing social relationships in the industrial and business life. In the development of this program, industrial, civic, and professional leaders of Pittsburgh will be brought into consultation.

The establishment of this new department in the training program at Carnegie Tech, the statement continued, is in line with the educational philosophy of President Doherty, who many times in addresses and in his writing has emphasized the point of view that the engineer must be trained not only as a scientific technician, but, what is equally important, must also be given a background that will make it possible for him to understand the social implications of the work which he does. He believes that the engineer has not assumed sufficient responsibility in our economic life, that his attitude has been too limited, that he has given too little thought to the social consequences of the technological civilization which he has been instrumental in creating.

Believing that this attitude can be corrected only by education during the formative years, President Doherty, who had had experience in developing a liberal program for engineering students at Yale, began shortly after he took over the presidency at Carnegie Tech to work with his faculty to revamp the course of study for engineers. This fall a new program was adopted in the College of Engineering providing the necessary time for social and humanistic studies. This was his first step to liberalize the curriculum, and thus furnish a broader cultural background for the engineer.

Now, having secured the support of the Foundation, President Doherty will be able to develop the new program of social studies for the engineering student. He plans a four-year course consuming perhaps one fourth of the student's total educational time, the remainder to be devoted to the usual engineering and scientific subjects. Through this program he hopes to bring about in the mind of the student a clear historical understanding of the parallel growths of science and engineering on one hand, and social customs, relations, and institutions on the other—in other words, a social consciousness and historical perspective of social evolution, especially since the invention of the machine. Along with this there would be other objectives, such as the ability to read purposefully and form intelligent opinions, the ability to organize thoughts logically, the capacity to use English effectively, and a continuing interest in all these matters after graduation.

While these are the broad objectives of the program, it will necessarily take some time to get such a plan fully in operation. So at the inception of the program next fall, a small group of students will be selected to study under the Maurice Falk professor. The course will consist principally of extensive reading in relation to a selected problem under professorial guidance, with reports at seminars. After the student has attained a broad general knowledge of social development, he will investigate thoroughly a few special economic and social questions. He will be assigned to a tutor in the particular field which he selects for detailed study. Then, following a program of supervised reading, he will report on his investigations, defending his findings before his classmates. Finally, having had the advice and suggestions of his tutor. and the criticisms of his fellow students, he will prepare his conclusions in written form.

Hand in hand with the plan of broader training for undergraduates will go a program of research in social studies. In this project a continuous effort will be made by investigators to understand social relationships as a whole, and how these are affected by technological progress. An assistant and several fellows will aid the Maurice Falk professor in these studies, according to tentative plans.

Science

Unless you stood near enough one of the groups conversing in the lobby of the Claypool at Indianapolis during the annual meeting, Dec. 27 to Jan. 1, of the American Association for the Advancement of Science, and thus were able to do a little genteel eavesdropping, you could not tell an astronomer from a zoologist, or a biologist from a botanist. So like ordinary folk are these men of science that even the Indianapolis Rotarians mixed with them without detection, a fact from which a considerable degree of satisfaction can be derived, for it is evidence of the vanishing quality of monasticism in science and of a union of it with the affairs and interests of daily life. Certainly, too, the very considerable amount of space devoted by the newspapers to the subjects discussed at this great gathering indicates an interest on the part of the public in the services performed for it in the name of science. Thus is brought closer the day when habits of thought take on more of the objective method of searching for truth where it may be found. Perhaps, too, it helped to advance the integration of the sciences themselves, and that unity of purpose and objective the world so sorely needs and that scientists themselves have not been too farsighted in bringing about. The attempt, more successful in plan than in accomplishment, to make a major feature of science and society, by means of a series of general lectures, first of a series of conferences on this subject, is an indication of the Association's realization that it has a mission to perform in common with other similar groups in other countries—unity among men of science and greater intellectual freedom in the great task of bringing light to perplexed peoples, adrift in social chaos and the religious fanaticism of nationalism.

This spirit was embodied in a resolution adopted by the executive committee of the A.A.A.S. and unanimously approved by the Council on the closing day of its meeting. The resolution reads:

> WHEREAS, Science and its applications are not only transforming the physical and mental environment of men but are adding greatly to the complexities of the social, economic, and political relations among men; and
>
> WHEREAS, Science is wholly independent of national boundaries and races and creeds and can flourish permanently only where there is peace and intellectual freedom; now, therefore, be it
>
> *Resolved*, By the council on this thirtieth day of December, 1937, that the American Association for the Advancement of Science makes as one of its objectives an examination of the profound effects of science upon society, and, that the Association extends to its prototype, the British Association for the Advancement of Science, and to all other organizations with similar aims throughout the world, an invitation to cooperate not only in advancing the interests of science, but also in promoting peace among nations and intellectual freedom in order that science may continue to advance and to spread more abundantly its benefits to all mankind.

Aside from the measure of hope that may be derived from this attempt on the part of men of science to concern themselves more intimately with the direction of conditions and the cure of abuses for which science itself may be a contributory cause,

an attempt in which engineers have been striving of recent years to make some progress, there was little of engineering flavor at the meeting and few engineers to participate in it. The Association is organized along lines of major interest into sections alphabetically styled from A to X, of which Section M is devoted to engineering. Every section has its officers and its individual program. The "General Program," a book of 273 pages, listed upward of 1200 individual papers, among which were general addresses to which all persons in attendance were invited. Chief of these general sessions were four held in the evening, and fully attended; the address by the retiring president of the association, Edwin G. Conklin, of Princeton, whose subject was "Science and Ethics;" the Sigma Xi lecture by Dr. Irving Langmuir, of the Research Department, General Electric Company, who spoke on "Biological Applications of Surface Chemistry;" the Phi Beta Kappa lecture, delivered by Dr. George Lyman Kittredge, of Cambridge, Mass., who stimulated and entertained his audience with a penetrating analysis entitled "Shakespeare and His Critics;" and an address by Dr. Thomas Parran, Jr., Surgeon General of the U. S. Bureau of the Public Health Service, on "Syphilis as a Public Health Problem."

CONFERENCE ON SCIENCE AND SOCIETY

From Monday through Friday, with a program of nine papers, a conference on science and society served to sound the keynote of the association's new venture in the broader implications of science and its impact on society. Under the general title, "Fundamental Resources as Affected by Science," these papers considered: controlled factors in economic development, agricultural and forest resources, mineral resources, power resources, capital resources, man power, the utilization of human resources, scientific methods of business organization, and research laboratories and the spirit of science.

Space will not permit the detailing of the subject matter developed in these papers. The first, however, read by Harold G. Moulton, president of Brookings Institution, Washington, D. C., explained the purpose of the conference and the scope of the plan of conferences to follow over the period of the next two years. The purpose of these conferences, said Dr. Moulton, will be to appraise in a more detailed and systematic way than it is possible to do in the first general conference the concrete ways in which science and social organization act and react upon each other. In these conferences it is hoped to get away from the generalities which have so commonly pervaded discussions in this broad field and attack the problem in very concrete terms with a view to revealing as definitely as possible where we stand today.

Subject to change, the general topics to be discussed at these later conferences are: standards of living as affected by science, the economic system in relation to scientific progress, government policies in relation to scientific progress, and science and human beings.

It is to be hoped that the future conferences will be given a wider publicity than that which preceded the first in order to attract the cooperative attention of all in attendance; for if the Association's new program is not to be abortive, men of science must be persuaded that these more general considerations of their work and its relationship to society and to individuals are quite as important as the discussion, in small groups, of the most recent advances in highly specialized areas of scientific knowledge. The place to begin a campaign for a better understanding of what science means to humanity and its institutions, and to promote peace and intellectual freedom, is among the followers of science. For, if its devotees are lacking in a spirit of cooperative understanding and concern for the direction and rate of progress, science cannot expect the world at large to assimilate rapid change intelligently or to use new knowledge wisely.

PROGRAM OF SECTION M

The program of Section M, Engineering, was presented in three parts: A general meeting, on Wednesday afternoon, which adjourned to participate in the discussion of the paper on "Power Resources," by A. A. Potter, president, American Engineering Council, past-president A.S.M.E., one of those delivered at the conference on science and society; two sessions of the Institute of the Aeronautical Sciences, held on Tuesday afternoon and Wednesday morning; and a luncheon meeting on Tuesday of the Institute of Radio Engineers.

At the general session on Wednesday afternoon, W. E. Wickenden, president, Case School of Applied Science, member, A.S.M.E., and retiring vice-president for Section M, A.A.A.S., delivered an address, "The Social Sciences and Engineering Education," the text of which will be found on pages 147 to 150 of this issue. Because of unavoidable absence, J. W. Barker, of Columbia University, vice-president and chairman, Section M, member A.S.M.E., and Frederick M. Feiker, executive secretary, American Engineering Council, secretary, Section M, member A.S.M.E., were represented, respectively, by M. R. Keefe, president, Indiana Engineering Council, and George A. Stetson, editor, A.S.M.E. Enthusiastic reception of Dr. Wickenden's address was attested by the prolonged discussion it evoked among the audience numbering about 50.

Dean A. A. Potter's election as chairman of the Section, to fill the office left vacant by the retirement of Dr. Wickenden, was confirmed by vote of the meeting.

Acknowledgment should be made of the efforts on the part of the Indiana Engineering Council, and its officers, M. R. Keefe, and Homer Rupard, secretary, member, A.S.M.E., in circularizing engineers in the Indianapolis area; and to Dean Potter and H. S. Morse, of Indianapolis, for last-minute services in arranging details of the session.

Mention should also be made of the services of Dr. W. F. Durand, past-president and honorary member, A.S.M.E., in presiding, as president of the Society of the Sigma Xi, at the lecture by Dr. Langmuir and at the Wednesday morning meeting of the Institute of the Aeronautical Sciences.

It would be profitable, did space permit, to report in some detail the excellent sessions conducted by the Institute of the Aeronautical Sciences and the Institute of Radio Engineers.

It would also be profitable to report fully the splendid address by Dr. Langmuir. Too much cannot be said in praise of Dr. Langmuir's ability to adjust his lecture to what must have been a disappointing last-minute discovery that no provision had been made for the display of the slides he had brought with him. In spite of this handicap, of which the audience had no intimation, Dr. Langmuir made clearly intelligible to a large audience the researches he has conducted over a period of years on layers of one molecule in thickness, and some of the vistas of future work in what is termed "surface chemistry" opened up by his studies. The simplicity of Dr. Langmuir's presentation fittingly parallels the direct simplicty of the experiments with monolayers which started with the supreme curiosity of a true student of scientific phenomena in the most casual and ordinary of observations. But what we know about what is daily before our eyes is pitifully small, and only the truly great look at it with comprehension. A photographic tray, filled with water, a drop of oil, some bits of silk, and a sheet of glass, yielded, under the eyes of Dr. Langmuir, most astounding results when interpreted by his analytical mind. The biological importance of the contributions a physicist has made to surface

phenomena lies in their possible application to the study of the fundamental cell structure of the human body and must be evaluated by the biologists who make use of this remarkable tool of research that Dr. Langmuir has provided for them.

MICROFILM READING DEVICE SHOWN

On Thursday morning, at a meeting of Section L, Historical and Philological Sciences, Watson Davis, of Science Service, reported on the preservation of scientific literature by means of the Bibliofilm Service, and demonstrated for the first time the microfilm reading machine soon to be placed on the market. Our issue of January, page 56, commented on the microfilm, and repetition of its use and value need not be made at this time.

The reading machine, which, it was announced, will sell for approximately $80, enlarges the microfilm, on which the reader's text has been photographed, to a size as large or larger than the original by casting it upon the ground-glass viewing portion of the instrument. By means of a crank the reader may bring instantly to view any page of the book or manuscript copied on the microfilm, and keep it before him as long as he desires. A device is therefore now available by which the microfilm can be examined with the greatest ease; and the Bibliofilm Service has acquired a powerful argument for its more general adoption and use.

OFFICERS ELECTED

Officers elected for 1938 included Wesley C. Mitchell, of Columbia University, president, vice-presidents of the Association and chairmen of the sections, members of the sectional committees, finance committee, committee on grants, executive committee of the council, and trustees of Science Service. A. A. Potter was elected vice-president and chairman of Section M, Engineering, and J. W. Barker, of Columbia University, member of the sectional committee for section M. F. R. Moulton, of Washington, D. C., is permanent secretary of the Association.

SCIENCE ON EXHIBITION

A science exhibition at the Murat Temple during the week of the meeting attracted many visitors. It contained much that interested men of scientific training—books, instruments, dietetic displays, medical specialties, agricultural exhibits, and a host of aids to mathematician, biologist, botanist, microscopist, physicist, agriculturist, teacher, and researcher in science. Displayed for the first time was the new Compton chart of electromagnetic radiations, before which one could stand for hours acquiring visually a conception of the entire gamut of waves, from the low-frequency electric ones to the high-frequency cosmic rays, and the various means by which they are emitted, measured, and produce effects.

Witnessing a demonstration of the educational possibilities of a robot lecturer, a motion-picture machine with voice, one wished that the planners of society might sit through the termite lecture and comprehend the significance of the supreme goal of the collectivist attained thousands of years ago by this humble but terrible insect and still today maintained by it. Attained without benefit of machinery and as yet only amateurishly copied by man, this object lesson in extreme specialization and corporate organization characterizes the shape of things to be in the ultimate fascist state with collectivism carried to its natural conclusion. Subsequent reading of the story by André Maurois about the ant colony that, although it starved to death, saved the last bit of honey for its queen, served to heighten apprehension.

Returning home through the fog that all but obliterated the winter landscape of Indiana corn fields, it was instructive to turn back two thousand years and more to the contemplation of the "Republic," by some unexplainable anticipation of its need thrust into the traveling bag, and here to read the inevitable cycle of human social institutions through aristocracy, timocracy, oligarchy, democracy, and despotism, and of the philosopher's ideal state. For, finding itself somewhere between the last two of the phases, the present generation needs most desperately the leadership of intelligence that science some day may provide. And, according to the philospher, "the essential form of good is the highest object of science."

Keller

On January 7, 1938, at Detroit, Mich., Emil Ernest Keller, industrialist and engineer, former vice-president of The American Society of Mechanical Engineers and associate in several enterprises of George Westinghouse, died at the age of 74.

Few incidents in Mr. Westinghouse's long career were as dramatic as the lighting of the Columbian Exposition at Chicago in 1893. With but a dangerously short time in which to complete and install the machinery and lights for the exposition, Mr. Westinghouse took a contract for the lighting, which was to be an important spectacular feature, at a ridiculously low figure, estimated by some to represent a saving of a million dollars to the Exposition Company. But Mr. Westinghouse counted on the advertising value of the contract to make up for any losses to the company. He did not, however, count upon not being able to use the incandescent lamp, and when the patent situation threatened to wreck his plans, he devised the famous "stopper" lamp, devised machinery and methods for its manufacture, and, in spite of its short life, the lighting was a success. It was Mr. Keller, a young man scarcely thirty-one years old, who operated the machinery and maintained the 250,000 lamps. The generating plant was the largest alternating-current central station then in existence, consisting of twelve 1000-hp units, each equipped with two 500-hp alternators. While the project is said to have represented a financial loss to Mr. Westinghouse, Mr. Keller affirmed a little more than a year ago, while discussing plans for the Westinghouse Celebration at the 1936 A.S.M.E. Annual Meeting, that, through the sale of the engines and generators, the loss was wiped out. But the demonstration did much to advance alternating current, and placed Westinghouse in a strong position when the hydroelectric plant at Niagara Falls was proposed.

Mr. Keller was born in New York City, Oct. 16, 1863, son of Jean Baptiste, of Mainz, and Suzanne (Brueck) Keller, of Giessen, Germany. From a memorandum in the Society's files, prepared by Mr. Keller in 1930, the following excerpts have been taken:

Being, from boyhood, intensely interested in science generally, he took up his own education by extensive reading of technical and scientific subjects within his reach, when not at his daily tasks, finally becoming self-educated in electrical and mechanical engineering while, at the same time, learning the machinist's trade with Yawman and Erbe, of Rochester, where he was advanced, in 1883, to the position of foreman of a department. In 1885 he entered into a partnership with two associates in machine construction and, after suffering the loss of the plant by fire, late in 1886, he was induced to become the superintendent of the Clark Novelty & Machine Co. of Rochester. Early in 1888 he removed to Pittsburgh, Pa., to enter the employ of the Westinghouse interests, engaging in electrical-engineering construction work and organizing the field construction department. Later, in the same year the Westinghouse Co. appointed him engineer and manager in full charge of installation and construction of electric lighting and power plants, covering the central West, with offices at Chicago,

negotiating contracts and building the first electric-lighting and power plants in many of the principal cities of the territory extending from Ohio to as far west as Ogden, Utah.

In 1891 he was, in addition, appointed chief engineer of the department of electricity of the World's Columbian Exposition at Chicago, and in July, 1892, he was selected by George Westinghouse to take the full responsibility of carrying out the Westinghouse Company's contract for lighting the grounds and buildings of the Exposition of 1893.

This work, covering all engineering and construction required and the operation of the plant during the Exposition, was carried out under his immediate personal supervision. He also supervised all of the electrical and power exhibits of the Westinghouse Company at the Exposition. Much of the equipment and most of the appliances for this extensive and, at that time, entirely new type of underground electrical distribution and exterior as well as interior electric-lighting effects, had to be devised or invented "on the spot" under the stress of very limited time available.

He completed this work so promptly and successfully that, at the close of the Exposition, he was, early in 1894, induced to return to Pittsburgh and become the vice-president of Westinghouse Machine Co.

Under his general management, in this position, the business grew to very large proportions. His office, during the next fifteen years, brought him into intimate personal relations with George Westinghouse, in business as well as in a social way, while developing the largest types of steam engines, steam turbines, and generators, as well as extending the field and sizes of gas engines from the small and inefficient units at first in limited use, to those of the largest capacities, including the first and still the largest gas engines operated with waste gases from blast furnaces, for electric power and for furnace blowing engines. These required also the development of washing and purifying apparatus for cleaning dust and other foreign matter from the waste gas. The now universally used and indispensable mechanical stoker, for steam boilers, was another new field of progress during this time; gas producers, steam condensers, of entirely new principle and type, and various other power-station requirements were added to the list of the company's major activities.

In September, 1895, he visited, at the request of Mr. Westinghouse, the electrical plants in England, France, and other parts of Europe personally to investigate the recent developments and the possibilities of the steam turbine as a commercially practical power unit.

This visit resulted in his negotiating a contract with Sir Charles Algernon Parsons, of Newcastle, England, for the exclusive control of the very valuable United States and Canadian patents of Parsons, the inventor and patentee of the only practical steam turbine then reasonably well demonstrated in moderate sizes to indicate future practicability of large units. He brought to America the first commercially useful example of a steam turbine seen in this country, which became the basis for development of Westinghouse steam-turbine units that are one hundred times as powerful as the largest reciprocating steam engines ever found practicable and are now used in the largest power plants and ocean vessels of the world.

In 1902, among all of his other interests and duties he undertook, for Mr. Westinghouse, the development of a new method for commercially manufacturing storage batteries, which resulted in the present extensive output of Westinghouse batteries. During his connection with Mr. Westinghouse, as vice-president and general manager of the Westinghouse Machine Company, he simultaneously acted as vice-president and director of several other important interests of which Mr. Westinghouse was the president and predominating owner, including Pittsburgh Meter Company, Westinghouse Foundries Company of Pittsburgh, East Pittsburgh, Trafford City, Pa., and of Attica, N. Y., Security Investment Company, Nernst Lamp Company, Westinghouse Inter-Works Railway Company, and others.

During the 1907–1908 financial panic he was the managing receiver of the Westinghouse Machine Company and affiliated interests, returning the company to its stockholders in sound condition in April, 1908.

In 1906 he had begun the development of interests in which he might be the principal factor, organizing the Detroit Insulated Wire Company in that year. In 1909 he changed his residence to Detroit and organized also, Metal Products Company, with large contracts over a term of years, to manufacture completely assembled axles and other finished portions of automobiles, for prominent manufacturers.

In 1911 he organized Insulating Materials Company and, in 1915, Standard Screw Products Company, all of Detroit. He became president of each of these and operated them all until merged with other concerns in late years. He was also an executive director of Detroit Motorbus Company, Michigan Terminal Warehouse Corporation, and others in which he had large interests.

As a youth, when with Yawman and Erbe at Rochester, his work was largely connected with microscopes, telescopes, and other optical apparatus. He did much of the mechanical work in the development of George Eastman's earliest roll cameras, in which Eastman, before the days of celluloid photographic films, used a roll of thin paper coated with the then new dry emulsion for photographic plates, which was faster than the wet collodion emulsion used on glass photographic plates of those days. This work aroused his interest in photography and microscopy, which became hobbies that lasted throughout his life and which led him to acquire a well-equipped home laboratory which occupied much of his leisure. From 1895 he was, for several years, president of the Pittsburgh Amateur Photographic Society and was responsible for the first and several following Pittsburgh Photographic Salons, exhibiting, in the Carnegie Art Galleries at Pittsburgh, the best work of the leading amateurs of the world.

While living at Chicago he patented an underground trolley system, for urban electric railways, and several automatically controlled and electrically operated rolling chairs, for conveying sightseers about the Chicago Exposition, and became interested in the earliest powered vehicles. He brought to Pittsburgh one of the very first "horseless carriages" introduced there.

Social Research and Engineering

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

AT THE 1937 Annual Meeting of the Society for the Promotion of Engineering Education, T. North Whitehead, of the Harvard Graduate School of Business Administration, presented a paper entitled "The Engineer as a Servant of Society," which may be read in full in the October, 1937, issue of *The Journal of Engineering Education*. From this paper the following excerpts have been taken:

Engineers, in the second half of the last century, were often referred to as the natural leaders of society. They pictured the benefits which would arise from a wealth of material goods. But for those of us now living, who have been trained as engineers, it has been a little disappointing to find that the administrator and politician have usually been the masters, with the

engineer as their paid assistant. The engineer has not quite taken that place in society to which his training and abilities would seem to entitle him.

The fact is, while the engineer has been decrying the administrator for a lack of scientific understanding, the engineer himself has not thought it necessary to investigate the nature of the society he has wished to lead. The engineer's conception of a good engineer has too frequently been formulated in terms of mechanical and economical efficiency; he has given little or no thought to social effectiveness when pursuing his work.

Our immediate problem is this: How can the engineer be so trained as to make his work contribute not only to the mechanical progress but also to the stability of our society? It seems that he must not only be trained to be an efficient engineer, but he must also be given the understanding of a wise administrator. These two skills must be taught to some extent separately. The technical skill remains technical. At the present time many engineering schools are attempting to give courses in one or more of the social sciences, but this movement has not been conspicuously successful.

A typical program is to teach the student a little elementary theory of economics and a sketchy course of the history of trade unions under the misleading title of "labor relations." The theory of economics is itself a highly abstract subject based on a very superficial understanding of human motives, while the course in labor relations represents an equally artificial account of a few negotiations, or trials of strength between groups of employees and their employers. These courses do not amount to a real study of human motives and human relations as they are found in an industrial society. For instance, the engineer is told nothing about the ways in which employees collaborate or relate with one another in their daily lives. No wonder the engineering student finds little connection between his interests as an engineer and his courses in the social sciences.

Professor Whitehead adduces examples to show the close relationship between engineering techniques and human relations and continues as follows:

Literally billions of dollars have been spent in discovering the properties of steel and as yet a negligible amount of research has been spent on understanding the human factor. But although we have not a sufficient body of knowledge to give the engineer a clear-cut answer to his social problems, yet something has been done. There is the material at least to direct his attention to the presence of these problems, to give him a few useful hints as to how to think about them and observe for himself.

As engineers we know better than to design a structure without any regard for its material environment. No engineer in his senses would design the foundation of a bridge without first finding out whether the bridge would rest on clay or rock. We make a thorough investigation of the material circumstances in which our machinery and structures have to function. We design locomotives differently for hot and for cold climates, for wood- and coal-burning districts. In consequence, we are thoroughly accustomed to research into the physical conditions which our commodities have to fit. Ultimately, however, the engineer does not work for the good of his material environment, but for the good of the human environment or society. And yet, surprisingly enough, engineers are not accustomed to investigating the nature of their society before proceeding with their work. An engineer, who would be laughed out of court for designing a foundation without a knowledge of the ground, will cheerfully design a mechanism or structure with only a hearsay knowledge of the human beings who are to operate it or to benefit from it.

Until educational establishments regard sociological research as being of equal importance with research of a more strictly engineering nature, it is inevitable that the student will conclude that all he needs is a knowledge of applied science and mechanisms, and that their application to society can be safely left to the man who pays the bill. Today wealthy institutions for the teaching of engineering habitually spend large sums on their workshops and laboratories, and then hire some junior professor of economics to look after a minor course in the social sciences. No wonder the student doubts its importance.

The bulk of engineering activity does not consist in the production of entirely new things but in the adaptation of existing mechanisms to particular situations, such, for instance, as the building of a given bridge or the development of a particular telephone service. It is in activities such as these that the engineer should be guided by a sociological approach.

He should come to regard the happiness and stability of the society or community he serves as his main function, and his knowledge of technical engineering should be for him a means to this end. Too often today the engineer regards the mechanism itself as his ultimate concern and the public as a troublesome, but necessary, adjunct in settling the bill. Only engineers who are placing the welfare of their society first can hope to be its leaders rather than its technicians. But this involves more than good will. A consideration for the welfare of society must be made effective by a serious and continuous research into the properties of the social process, its generalities, and its individual differences. This type of research has barely started here and there; but, if our industrial civilization is not to be destroyed by haphazard innovation, such investigations must be a prime concern of those responsible for the march of technical progress.

An exactly analogous situation has arisen in the university training of business administrators. These men share with engineers the practical control of the social process; and until lately it was considered sufficient to teach them the techniques required for the running of an enterprise, without paying any great regard to the repercussions of these on society at large. More recently it has become increasingly clear that the business man, together with the engineer, has come close to disrupting the society he was supposed to serve; moreover, it is evident that a business cannot hope to be more stable than the society of which it is only a part. Consequently, business schools have been turning their attention to the wider training of their students as responsible members of society.

Another reason why sociological research will always be important to the engineer arises out of the difference between one human situation and the next. For just as the human relations of any two factories, or any two communities, have something in common, so do they also have their characteristic differences. A generalized knowledge of sociological fact will never be sufficient for the engineer. He will always have to supplement this with a particular study of the actual human situation for which he is designing his mechanism.

Society cannot continue to tolerate highly trained engineers whose interest is exclusively centered in the details of their mechanisms. If the engineer is to be of help to his society, rather than a disruptive influence, he must be in essence a social leader who has at his command certain scientific skills. But social engineers will not arise until the great engineering schools recognize the collaborative activities of mankind as one of their major fields for research, and until those in charge of these schools regard money spent on this type of research as being of equal importance with that spent in exploring the nature of materials or in the development of mechanism.

Unless we can train engineers whose interest in the vital so-

cial processes is comparable to their technical interests, I fear that we engineers may be paving the way for a companion volume to Gibbons' "Decline and Fall of the Roman Empire."

Electromagnetic Couplings

THE INSTITUTE OF MARINE ENGINEERS

IN A PAPER presented before the Institute of Marine Engineers in England on Nov. 9, 1937, G. L. E. Metz and N. Ericson describe "Electro-Magnetic Slip Couplings for Use with Geared Diesel Engines for Ship Propulsion." The functions and characteristics of the coupling are discussed and the electromagnetic principles on which the design of the coupling is based are outlined. The application of the coupling to high-speed geared Diesel engines is examined and several installations in service on various ships are described.

The general construction of the coupling is shown in Fig. 1.

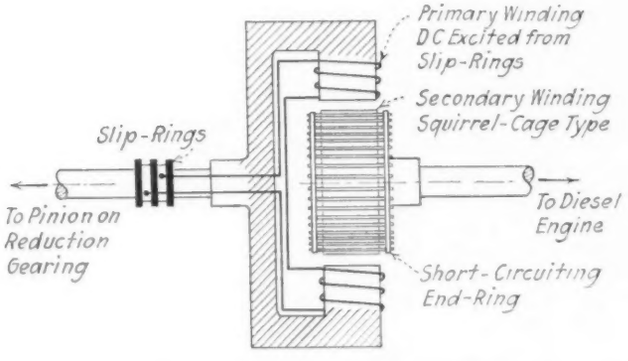


FIG. 1 ELECTROMAGNETIC SLIP COUPLINGS

As shown, the construction is simple and comprises two electromagnets; the primary electromagnet is mounted on one shaft and is excited from the ship's auxiliary direct-current supply, and the secondary electromagnet is mounted on another shaft and excited inductively. The primary part is actually a multipolar magnet ring and is connected to the high-speed pinion-gear shaft, and the secondary part is provided with a short-circuited winding and is connected to the Diesel engine. Except for constructional reasons, these positions can be reversed without affecting the characteristics of the coupling. The two parts of the coupling are overhung on their respective shafts separated by a radial air gap (rubber-covered bolts are provided for emergency use). Depending on the value of the torque to be transmitted and the speed of the engines, the air gap varies between 0.2 in. and 0.4 in.

When the primary part of the coupling is excited and rotated, a magnetic field is produced and the lines of force pass from the pole across the air gap cutting the conductors of the secondary part of the coupling and inducing a current in them. A torque results from the interaction of this current and the magnetic field which causes the secondary system to rotate.

The couple is made and broken in the coupling by the closing and opening of the switch which controls the supply to the excitation circuit. In practice, the coupling is generally kept excited all the time the engines are in use and the various maneuvers are carried out on the engine controls. The engines are therefore started, run, and reversed just as in the case of a direct-controlled Diesel drive. The propeller speed follows the engine from moment to moment without any greater difference in speed than 1 or 2 per cent (the slip is required to give effective protection to the gearing against shock due to speed fluctuations), and there is no time lag between the control of the engines and the control of the propeller. The efficiency of power transmission through the coupling is high, being of the order of 98 to 99 per cent.

The arrangement and over-all dimensions of an installation in the M.S. *Astrid Thorden* using two 1050-bhp Diesel engines running at 300 rpm coupled through slip couplings and single-reduction gearing to a propeller running at 130 rpm are described. On the M.S. *Dagmar Salen*, put into service Sept. 8, 1937, four 1100-bhp Diesel engines running at 300 rpm are coupled through slip couplings and single-reduction gearing to a propeller running at 90 rpm.

Progress of Rocketry

DISCOVERY

UNDER the title, "Is Rocketry Progressing?" Charles G. Philip presents a popular résumé of this fascinating subject in the September, 1937, issue of *Discovery*. The more responsible rocket experimenters, says Mr. Philip, realized long ago that before the rocket can be successfully harnessed in the service of man an immense amount of experimental and physical work must first be carried out.

To give an idea of the nature and extent of this work he reminds his readers that because combustion in the gunpowder rocket was uncertain and generally uncontrollable, liquid fuels, which could be controlled quite easily by valves, were substituted. After much experiment and research it was found that the most suitable mixtures are liquid oxygen and alcohol, liquid oxygen and gasoline, and liquid oxygen and liquid hydrogen. Liquid fuels necessitated experimental work to find the proper construction of combustion chambers and nozzles and various methods of fuel injection.

With combustion temperatures well above 3000 F the construction of suitable combustion chambers and nozzles proved a problem of first magnitude, but one that is not insoluble.

Mr. Philip pays high tribute to the work in this country of Professor Goddard over a period of more than two decades. In 1936, he says, Professor Goddard announced that he had successfully achieved stabilization of the rocket, and he is now directing his efforts to the problem of weight reduction and to the investigation of lightweight and heat-resistant alloys. He is reported to be confident that he will be able to produce a meteorological rocket capable of ascending to a height of 50 miles or more. Professor Goddard's first liquid-fuel rocket, in 1926, attained a height of 184 ft in 2.5 sec, a speed of 60 mph. In 1935 his rocket rose to a height of 14,000 ft and attained a speed of 700 mph.

The author says that in spite of the difficulties attending experimentation in rocketry, before long early and important developments are likely to be witnessed. He quotes "strong rumors" in "well-informed rocketry circles" to the effect that the British government has actually started work on the first military rocket plane, and says that in France, at the Paris Exposition, the Minister of the Interior ordered the astronomical section to include a subsection on rockets and space flight. This, he asserts, is the first occasion rocketry has received governmental recognition.

One reason for interest on the part of military authorities in rocket propulsion is given by the author as follows:

The present type of pursuit airplane weighs perhaps some 4050 lb, and it can attain a height of 20,000 ft within eight minutes of the start. By equipping this type of airplane with

rocket engines, complete with rocket fuel, an extra weight of 1000 lb would be incurred, 750 lb of which would be fuel. A pursuit plane equipped with dual engines of this type—aero and rocket—would have its normal starting path, which could now be made at an angle of 30 deg, shortened by fifty per cent. Using the rocket engines as an auxiliary to the aero engines, a pursuit plane, thus equipped, would attain an altitude of 20,000 ft within one and a half minutes from the start, compared with eight minutes by aero engines alone.

Steel

THE FRANKLIN INSTITUTE

BEFORE The Franklin Institute, Philadelphia, on Nov. 11, 1937, John Johnston, director of research, United States Steel Corporation, delivered a lecture on steel in which he reviewed in a generally nontechnical manner some of the advances in the making and use of steels brought about by research. He said that it now looks as if no further appreciable lessening in the dollar cost of steel is possible through the use of still larger units or of further mechanization; there is, however, the possibility of improving quality to the end that there be a steel just suited to each of the many purposes for which steel is used, and it is along these general lines that the industry is now earnestly endeavoring to make progress. The probability of inventing by chance a steel that is capable of satisfying new groups of requirements is small, as the properties of a steel depend not only upon what is put into it but also on just how it is made and treated, he pointed out.

The new era in the making and utilization of steel we are now entering, he said, will enable us to build structures which are lighter in weight for a given load, or which may be safely used under more severe conditions of stress and temperature. Substitution of thinner for thicker materials, he continued, means that in service the metal is subject to a higher unit stress; and in general it is not safe unless the metal has an appreciably higher resistance to atmospheric corrosion than was required before. Hence, he argued, a steel to be substituted in order to save weight must, since there can be no appreciable reduction in weight per volume of the steel itself, be both stronger and more resistant to corrosion.

Our interest lies, he said, in the real intimate structure of steel, and not, or only secondarily, in its chemical composition as ordinarily given. Two steels, nominally identical in composition, may show wide differences in the way they have been made and handled which brought about differences in their intimate structure. The problem then is to correlate properties with this structure, rather than with chemical composition as such, and thereby learn how to get the structure required for any specific use most easily and cheaply. This may be a carbon steel, properly made and treated, or it may be an alloy steel containing one or more alloying elements in the right proportion for the purpose.

Resistance to a given type of corrosion, he said, is primarily a matter of the chemical composition of the metal and of the homogeneity of its surface, for these factors determine whether the metal can of itself set up an effective continuous barrier to protect it from further reaction with its environment. It is now generally agreed that the protective barrier against atmospheric corrosion—which is quantitatively the most important type of corrosion—is some kind of oxide film; but we are still very much in the dark as to why some oxide films are really protective whereas others are not. This general question is now being more carefully studied than ever before, but no general conclusions can yet be regarded as established, and consequently we still lack a guiding principle in searching for combinations which will resist common types of corrosion. As a matter of experience, we know that chromium (like aluminum and silicon) readily forms an almost invisible protective oxide film, and that chromium-iron alloys containing more than about 12 per cent chromium in solution form automatically a similar film in an oxidizing environment, thus that the outstanding resistance to corrosion of the group of so-called stainless steels is due mainly to the chromium. On the other hand, ordinarily rust is, as everybody knows, not very effective, yet the rust which forms on a steel containing about 0.25 per cent copper is a better protection, and the oxide coat formed on a steel containing small quantities of copper, phosphorus, chromium, and silicon proves to be distinctly effective as a barrier to continued corrosion. These differences are a matter of experience as a result of tests extending over years upon a large number of different compositions; what they are due to is unknown, and remains the subject of active investigations.

A great deal of effort, he continued, is being directed toward learning the precise effect of graded proportions of each practicable alloying element (the total number of which, about a dozen, is smaller than is commonly believed), alone and in combination with others, upon the molecular structure of steel subjected to all kinds of mechanical treatment and of temperature-time cycles. The information now available, though the result of an enormous amount of work, is uncertain, in part contradictory, and at best far from complete. To clear up this situation is a gigantic undertaking which will leave plenty of work for our successors to do. In the meantime there should be a gradual further rationalization, and ultimately a simplification, of the use of steels; and this should bring about a lessening of the number of minor differences, without real significance, in the specification relating to steel composition, and lead toward the production of steels each still better adapted to its particular use than is now always the case. This implies close cooperation between the user and maker of steel, and mutual understanding of the problems each is facing.

Railroad Air Conditioning

ASSOCIATION OF AMERICAN RAILROADS

CONTINUING the studies noted in this section in the April, 1937, and August, 1937, issues, the division of engineering research of the Association of American Railroads issued in October, 1937, a report on the road performance of air-conditioned Pullman sleeping cars. It presents the results of performance tests of 24 Pullman cars on 27 regular-service runs by engineers assigned to the division of equipment research for this work.

The tests were made for the purpose of obtaining factual information concerning the performance of the air-conditioning equipment in road service. Information was obtained regarding (1) inside temperature and relative humidity (a continuous record was obtained of the inside temperature and relative humidity throughout the run made with each car by means of a tempera ture and humidity recorder placed upon a seat in the passenger-occupancy section of the car), (2) outside temperature and relative humidity (the outside temperature and relative humidity were determined by means of a psychrometer, as frequently as possible), (3) temperature distribution (this was determined by means of a psychrometer at heights equivalent to head and ankle levels of a seated passenger with readings being taken within the sections at both ends and center of the car, as well as in drawing

rooms and compartments, (4) air movement, (5) volume of air —outside and recirculated air, (6) roadbed radiation, and (7) precooling of cars before passenger occupation.

A brief summary of the results obtained based on present authoritative standards of measurement follows: The inside temperature was kept fairly constant between 72 and 78 degrees in the daytime in summer weather, and slightly lower at night. On eleven runs, the inside relative humidity was above 70 per cent during some part of the run as compared with the accepted standard of 30 to 60 per cent which should be maintained. In all cars, the variation in average temperature from end to end of the occupancy sections of the cars was within the two-degree variation considered desirable. The desirable air movement of 25 to 75 fpm was maintained in most of the cars. However, the average volume of outside air delivered to the cars was greater than 20 cfm per passenger for all but five runs, which is very much over the 10 cfm per passenger considered satisfactory. An analysis of the data gathered indicates that roadbed radiation has little, if any, effect upon the temperature of the air for cooling the condensers. It was found desirable to precool cars prior to passenger occupancy, otherwise undesirably high temperatures were recorded in four of the cars at leaving time.

Variable-Speed Gear

THE ENGINEER

A VARIABLE-SPEED mechanism known as the "H" gear is described in the July 2, 1937, issue of *The Engineer*. The gear is said to be available for incorporation in machine tools and for other engineering purposes in units capable of transmitting up to 10 hp.

Fig. 2 shows the principle of the H gear. The input and output shafts, *A* and *B*, of the mechanism are splined and have mounted on them two pairs of hardened and ground cones, *C*, *D*, *E*, and *F*. Power transmission between the shafts and cones is effected by means of a hardened and ground steel con-

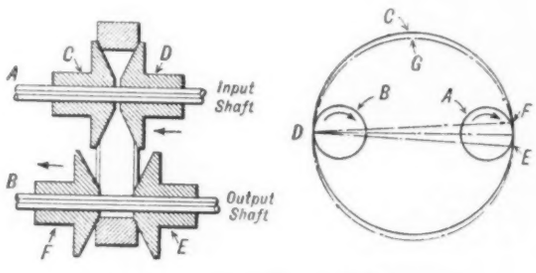


FIG. 2 ARRANGEMENT OF "H" GEAR

necting ring. The cones *C* and *E* are fixed to their respective shafts, but cones *D* and *F* can slide along their shafts, together with their bearings and bushes. The operating mechanism controls the motion of the movable cones *D* and *F* so that, when the distance separating cones *C* and *D* is increased, the distance separating the other pair of cones is correspondingly decreased, and vice versa. By means of this motion the relative position of the ring alters and the ratio of the peripheral velocities of the respective lines of contact can be varied, thus varying the relative speeds of the shafts.

Each cone is supported by a ball bearing in the housing which encloses the mechanism and operating gear. It is claimed that this method of mounting relieves the shafts of all stresses except the driving stresses. The illustration on the right of Fig. 2 shows how the contact pressure between the ring and the cone is automatically increased in proportion to the power transmitted. It is stated that slip is completely eliminated and that, since no preloading device is used, the idling losses are considerably reduced. When running under no-load conditions the ring *C* makes contact with the cones *A* and *B* at points *D* and *E*. An application of load produces a reaction which tends to move the ring into a position, such as shown at *G*. The point of contact of the cone *A* is therefore shifted away from the diameter *D E* to a new position, such as *F*. The distance *D F* is less than the distance *D E*, and therefore a type of wedging action will occur, the amount of which, it is claimed, is proportional to the power being transmitted.

Textile Wear Testing

AMERICAN SOCIETY FOR TESTING MATERIALS

THE wear or serviceability furnished by the fabrics used for wearing apparel and in the household affects nearly every person to some degree. However, the ultimate consumer is usually not equipped to secure such data for himself and must rely upon the information secured from the seller, manufacturer, governmental bureaus, and those organizations especially representing consumer interests. The different machines and methods used in obtaining this information are described by Prof. H. J. Ball, member, A.S.M.E., in a paper entitled "Abrasion and Wear Testing Machines for Textiles," presented at the fall meeting of Committee D-13 on Textile Materials held in New York City, Oct. 20 to 22, 1937. The paper with several illustrations of testing machines is published in the *A.S.T.M. Bulletin* for December, 1937.

The first part of the paper deals with a description of the mechanical features of eleven textile abrasion- or wear-testing machines developed by manufacturers and by the laboratories of certain industrial and governmental organizations. The relative merits of the various testers are not compared but the description of each machine gives essential information in respect to the character of motion and size of the sample and abradant, control of pressure and tension, automatic and recording features, over-all dimensions, and power requirements. One of the machines, called the "Perspirator," reproduces conditions of perspiration and warmth in the testing of lining materials.

However, none of these machines or methods can be applied universally, according to Professor Ball in the second part of his paper, because the problems in wear testing differ so greatly. Wear affecting carpets, for example, differs so greatly from that affecting a man's suit that it is entirely out of the question to consider a like test for each material. Even the different fabrics used in the suit itself are subject to conditions sufficiently different to cast a doubt upon the possibility of a single wear test for them.

How closely should a laboratory wear test duplicate an actual set of service conditions? If attempts are made to reproduce all of them, it will certainly require in some instances a complicated machine and procedure. The answer is the determination of the cause or causes of greatest wear. With this information at hand, the wear-testing machine should be planned to reproduce only those influences which are accountable for the major portion of the total destructive effect. One important point to keep in mind is the usual purpose of the tests. It is not required that they forecast the service life of a material in terms of some unit of time. Rather the problem is one of comparison, of determining such facts as will warrant an opinion that a fabric probably will or will not last longer than another. This

limitation of purpose tends to reduce the requirements of wear testing and makes the problem one of producing the simplest apparatus which will rate the fabrics in their proper order, a procedure which may or may not closely duplicate the actual conditions of use.

How may the effects of abrasion be measured? Measurement should yield a quantity proportional to the effect of the frictional force; in other words the selected measure should be one that is reasonably sensitive and proportional to the work done upon the sample. Various measures have been suggested, of which the important ones are the changes produced in the (1) tensile strength, (2) thickness, (3) weight, (4) surface luster, (5) air permeability, (6) color, (7) character of abraded materials, and (8) appearance of surface. The first six represent properties which it is possible to measure physically, and this is a feature considered to be an advantage by those who prefer to have numerical values to back up their opinions of a fabric. The last two would be determined with the aid of a microscope, and possibly by comparison with established standards, but are of such a character that the personal equation enters to some degree in the formation of an opinion. The measure which should be selected for a particular investigation would primarily be governed by the nature of the service conditions of the cloth which is being tested. It is hoped that the few points presented here will merely emphasize the extent to which care and judgment must be exercised in planning wear or abrasion tests and the fact that even greater judgment must be used in interpreting their results.

Composite Aircraft

IMPERIAL AIRWAYS GAZETTE

IN PREVIOUS issues attention has been called to the Short-Mayo composite aircraft, designed by Major R. H. Mayo, general manager (technical) of Imperial Airways. The main purpose of this invention, according to *Imperial Airways Gazette* for October, 1937, is to provide a solution to the fundamental problem of long-range flying, namely, the difficulty of getting an aircraft safely into the air with the heavy load of fuel required. With the composite design, the heavily loaded aircraft which is to operate the long-range service is relieved of the necessity of taking-off by itself and is assisted into the air by an auxiliary aircraft to which it is rigidly attached.

The two-component aircraft together form a composite aircraft, which is, in effect, a biplane of normal characteristics and capable of taking-off quickly and easily after a comparatively short run. For technical reasons the long-range-service aircraft forms the upper component of the composite aircraft and the auxiliary aircraft the lower one.

When the composite aircraft has climbed to a suitable height and has settled down to steady level flight, the locking mechanism securing the two components together is released and the components thereupon automatically separate.

The upper component rises clear of the lower and proceeds on its long-range flight, while the lower component returns to the base in readiness for the launching of another upper component, or for other service as a normal aircraft.

The provision of means to insure safe separation of the two components, without risk of fouling or subsequent collision, is one of the fundamentals of the composite-aircraft invention. This is achieved by the automatic generation of a powerful aerodynamic force tending to separate the two components and the provision of a special locking and release mechanism which prevents detachment of the components unless the separating force acting at the moment of detachment be sufficient to insure their rapid vertical separation.

The release mechanism is simple yet foolproof and has been subjected to exhaustive tests to insure its satisfactory functioning. As a result of these tests it is confidently anticipated that the separation of the components can be safely effected in all normal weather conditions and that the composite aircraft can thus be operated for regular long-range services in all parts of the world. An important feature is that separation can be effected at any desired height, so that even in very bad weather conditions it should be possible to find a height at which separation can be safely effected. If, however, for any reason it is desired to return to the base without effecting separation of the components the composite aircraft as a whole can land safely as a single aircraft.

During the flight of the composite aircraft as such, control is vested solely in the pilot of the lower component, the controls of the upper one being locked. The controls of the upper component are automatically released as detachment occurs. This feature eliminates the risk of trouble due to divided control and consequent misunderstanding between the two pilots.

Synthetic Rubber

INDIA-RUBBER JOURNAL

SYNTHETIC rubber-like materials are more properly regarded as new raw products applicable to new purposes, than as possible competitors for natural rubber, according to T. L. Garner in the international issue of the *India-Rubber Journal* for November, 1937. He traces the history of synthetic rubber materials back to 1860 when Williams, an English investigator, isolated isoprene by distillation of natural rubber, and the French chemist Bouchardat, and later the Englishman Tilden, showed that on standing or treating with acids an artificial rubber could be produced. This led to the discovery in 1884 by Tilden that isoprene could be made from quite another source, namely, turpentine. Other investigators quickly followed up Tilden's work, and the first methyl rubber—the type made in Germany during the World War—was produced by Kondakoff.

Germany was able to produce during the war period only a few thousand tons of this material. Although of poor quality, this material helped to meet the pressing need for rubber, and efforts to improve the quality resulted in the development of organic accelerators and antioxidants. The synthetic-rubber industry in Germany can be said to have begun in 1926, when a sufficiently economical process for the preparation of butadiene, the basic material, was made available.

Nieuwland made the discovery which eventually led to the production of Neoprene in America. A brief description of the process used in making Neoprene can be found in this section in the April, 1937, issue, of MECHANICAL ENGINEERING. By using chlorine in the preparation of this product, a quicker and cheaper method of processing synthetic rubber was made possible.

The sulphur-type synthetics originated in America in the early 1920's from experiments by Patrick in the production of antifreeze chemicals. Upon mixing together ethylene dichloride and sodium polysulphide, he obtained, instead of the anticipated new liquid antifreeze, a gummy mass which looked and felt like rubber. Years of further work resulted in Thiokol, which was placed on the market in 1931.

It must not be forgotten that Russian chemists also figured largely in the pioneer work preceding the commercial produc-

tion of synthetic rubber. Today, a large industry exists making synthetic rubbers from alcohol by what is known as the S.K.B. process, using butadiene as the real starting point of the synthesis. Very little is known of the actual processes and economic data outside Russia, although it is well known that the output of synthetic rubber has reached a high figure.

The materials generally available for production have been Neoprene, distinguished from other types by its chlorine constituent, and a variety of sulphur-containing synthetics, of which the American-produced Thiokol group is perhaps the best known. The German group of Buna rubbers, which are produced by various processes of polymerization from butadiene, have not hitherto been generally available, although the Buna type N, produced by polymerization in aqueous emulsion, is now coming on to the open market. Russian types are also polymerization products of butadiene, but these are not exported.

Though not all the new products show equal resistance to oils, most have very much better qualities than rubber compositions. Advantages have also been found in certain electrical applications. Synthetic products also age better than rubber, particularly as regards flexing, and tires with synthetic-rubber side walls show a complete absence of the familiar fine cracks, even after the tire has completed its life. Gases diffuse less readily through synthetic-rubber compositions, a fact of the greatest importance in connection with balloon fabrics and similar materials. Another advantage of the product over rubber is its resistance to ozone, which makes it very useful to the cable industry for wire and cable covering.

Certain difficulties in compounding and handling are some of the disadvantages of the new synthetic materials. They behave differently with different kinds of oils, and the preparation of a suitable compound to give perfect resistance to the most active of these is a difficult matter. Even with the utmost care, the molding possibilities at present are very limited, and for complicated moldings use must be made of other types of synthetics, or mixtures of various types, depending on the nature of the problem to be solved. Finally, there is the restricted use in household applications because of its odor; however, it is reasonable to expect that this will be ultimately removed. Present disadvantages such as these do not detract from the great progress which has already been made in this vast new field of discovery, and the extensive commercial application already made possible.

Metal Flow in Tube Extrusion

THE METAL INDUSTRY

PIERCING and extruding of copper tube was briefly described in this section of the October, 1937, issue. Discussing his study of the flow of metal in tube extrusion, Clement Blazey, a metallurgist of Australia, in an article in *The Metal Industry* for Oct. 8, 1937, concludes that the mode of flow is in essentials similar to that which occurs in rod extrusion by the direct method.

Using a 600-ton press capable of producing tubes up to $2^1/_4$ in. external diameter, Mr. Blazey describes his application of three methods of examination, namely, (1) stamping marks on the outside of brass billets and noting their positions at the end of the extrusion, (2) stopping the extrusion at different stages and removing the partly extruded billets from the press, sectioning them vertically, and etching them to develop grain structure, and (3) preparing composite billets and examining them at successive stages of extrusion. The weakness in the first method lies, according to the author, in the danger of assuming that because the outer layer of a billet remains stationary during extrusion the metal beneath is also stationary. However, in combination with the other methods, this method provides information on the nature of the flow.

An examination of etched sections revealed that when a brass billet is compressed at high pressure before being pierced by the mandrel, and a short length of solid rod is forced through the die, the flow is similar to that in ordinary rod extrusion by the direct process. But when the stem is brought down at low pressure, and the mandrel forced through, severe distortion is confined almost entirely to the metal surrounding the mandrel, as shown in Fig. 3, where the dotted region represents the as-cast structure and the hatched region represents the distorted, partly recrystallized, structure. As the billet shortens, the comparatively immobile regions diminish in volume until, near the finish of extrusion, only the bottom outer corner *b* appears to retain much semblance of the cast structure. Metal from *a* is carried down by the mandrel and pad to form a portion of the inner wall of the tube. Similar changes are to be noted during

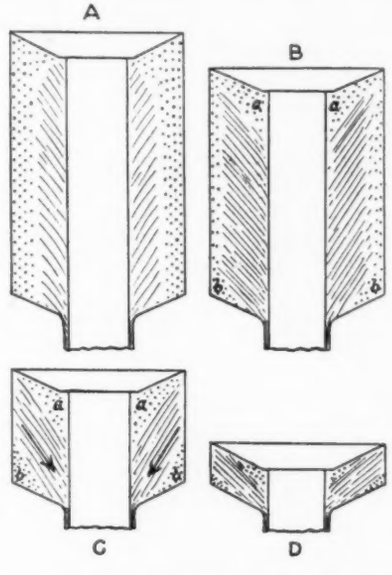


FIG. 3 BILLET SECTIONS AT DIFFERENT STAGES OF EXTRUSION, ILLUSTRATING CHANGES IN CRYSTAL STRUCTURE

(Dotted areas indicate where as-cast condition predominates and hatched areas where intense distortion and recrystallization have occurred.)

the extrusion of 70/30 copper-nickel billets where the persistence of coring is more marked than in brass.

In the third method of examination, interesting results have been obtained with aluminum-brass billets with copper disks riveted on each end. The first portion of tube consists largely of copper with a thin inner wall of brass, but, as extrusion proceeds, the outer wall of copper diminishes in thickness while the inner wall of brass increases until the tube is composed largely of brass. After about one third of the billet has been extruded, the top disk of copper appears on the inner wall of the tube as a thin film which increases to a considerable thickness and then thins off again for the remainder of the tube. At the end of the extrusion, only a thin layer of copper is to be seen near the junction of pad and mandrel. The lower disk of copper, however, not only supplies the material for the whole of the outer wall of the tube, but it constitutes about one half of the residual metal left between die and pad at the completion of extrusion.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Simple Hydraulic Dynamometer

To the Editor:

First, let me pay tribute to the generous spirit that prompts Professor Culver[1] to lay before the A.S.M.E. the results of so much work. Then I want to agree with him that a plain smooth disk revolving in a casing partly filled with water is the simplest form of hydraulic dynamometer. My earliest experience was with the old-fashioned block brake used on steam-engine band wheels. How it would grab and jerk and smoke on just a little provocation! About twenty years ago, I had to design a brake of some kind to calibrate a 500-hp steam turbine at 3000 to 3500 rpm. Study of power absorbed by smooth disks rotating in water led to using four 24-in. smooth steel disks rotating in separate compartments of a built-up casing. To provide a variable load at constant speed, a throttle valve was used on the water inlet. In operation the brake ran smoothly and noiselessly and the scale beam for a given load could be kept floating by handling the inlet valve.

Theoretically, a centrifugal-pump impeller should absorb horsepower by the cube of the relative change in speed. The values of n in Table 1 show how closely this is approximated on test. And theoretically a change in diameter should cause power to be absorbed at constant speed by the cube of the relative change in diameter, provided the quantity of liquid handled changes in proportion to the relative diameters. Power absorbed in run No. 32 with a 10-in. rotor is 30.9 times that of run No. 1 at 2000 rpm, which approaches the fifth power of diameter as called for by Equation [5], which may be derived by assuming that the resisting force varies as the square of the velocity. Tests by other experimenters have shown that the coefficient of fluid friction varies with speed, but not quite in simple proportion. I have found a simple change in casing to make 40 to 50 per cent change in head for a given impeller. Has Professor Culver anything further on this point?

C. V. Kerr.[2]

To the Editor:

This is an interesting paper on a subject where we do not have very many data. It seems to show that these viscous dynamometers follow closely the given law which is clearly brought out by the way the author has plotted the results. His simple method of regulation is also interesting. To make the information a little more complete, Professor Culver should give the possible sources of error with this brake, such as the friction of the supporting bearings of the movable part of the brake.

I am surprised to see that the effects of cavitation do not appear to show up on his curves at higher speeds of the brake. Is it possible that there may be local cavitation which is counterbalanced by more effective action of some of the other blades? In general, cavitation will soon put the brake out of business if it occurs, and in this connection could the cavitation be eliminated and the capacity of the brake be increased by introducing air pressure at the center of the brake and supplying the water at a considerable head?

Harte Cooke.[3]

To the Editor:

I agree with each of Mr. Kerr's observations. According to Equation [5] of the original paper, a viscous dynamometer having four revolving disks 24 in. in diameter would have a maximum capacity of 1260 hp at 3000 rpm. As the paper suggests a factor of about 3 in designing for use under practical conditions, and in the above case the factor is 2.5., evidently the data used by Mr. Kerr were well-chosen for his purpose.

The liquid leaving the impeller of a centrifugal pump having radial vanes has a total energy equal to the sum of that due to (*a*) the centrifugal head produced in the impeller and (*b*) kinetic energy. In the ideal case, each of these items is equal to the velocity head, $u^2/2g$; and their sum is equal to the input energy. A perfect casing would be one capable of converting all of the kinetic energy (*b*) into useful head, thus doubling the head and the efficiency over that obtaining if all of the kinetic energy were dissipated as heat.

Mr. Cooke's suggestion of means for eliminating cavitation by increasing internal pressure within the dynamometer casing would seem to be in line with recent investigations. Of course, this would preclude the use of a self-balancing scheme as simple as the one described in the paper.

Edward P. Culver.[4]

Residence and Small-Office Air Conditioning

To the Editor:

The paper[5] gives definite data on a subject which is of intense interest to householders and engineers in many parts of the United States. These have been presented in such a form that they can be easily changed to conform to the requirements of other localities with their differing climates. This is especially valuable.

It is interesting to note that the measured heat load was approximately 25 to 30 per cent less than the calculated one based on standard coefficients and similar data. This same ratio between measured and calculated heat loads was found in a large office building. Mass effect of the building, however, might be expected to vary in different climates, depending on average twenty-four-hour daily temperatures and shape, construction, and orientation of the building, so a factor involving mass effect should be selected with great care.

I agree with the author that on extremely warm days the conditions in a house may be allowed to rise to 80 F with an effective temperature of 74. It should be understood, however, that this

[1] "Investigation of a Simple Form of Hydraulic Dynamometer," by E. P. Culver, Mechanical Engineering, October, 1937, pp. 749–753.

[2] Consulting Engineer, Los Angeles, Calif. Mem. A.S.M.E.

[3] Mechanical Engineer, Diesel Engine Division, American Locomotive Company, Auburn, N. Y. Mem. A.S.M.E.

[4] Associate Professor of Mechanical Engineering, School of Engineering, Princeton University, Princeton, N. J. Mem. A.S.M.E.

[5] "Residence and Small-Office Air Conditioning," by G. B. Helmrich, Mechanical Engineering, October, 1937, pp. 743–748.

condition is on the warm side of the comfort zone. This summer I had an opportunity to test this point and determined that personally I was somewhat uncomfortably warm when lightly dressed and without a coat. Effective temperatures which are higher than this might be classed only as preferable to a warmer out-of-doors.

In a three-story house, the attic fan has proved successful in removing the heat of the sun from the attic above the top floor. When the fan was operated, the temperature of this floor did not exceed that outside. Correspondingly lower temperatures were obtained after sunset, which produced possible conditions for sleeping. The effect of the fan was also noticed in cooler conditions on the second floor. This same house was also equipped with a furnace fan, which was operated during hot spells. Noticeable improvement in comfort conditions in the rooms resulted from the slight air motion set up by the fans. That unpleasant feeling of dead air which is experienced in a closed house was entirely eliminated.

My experience has been that, in nearly all cases, sufficient air through infiltration will satisfy ventilation requirements in a residence. However, in two cases that I recall, the houses were so tight that other means for ventilation were found to be necessary.

A. E. STACEY, JR.[6]

[When Mr. Helmrich's paper was published, Figs. 2 and 4 were through error, transposed.—Editor.]

Arc-Welding Practice in the Machine Shop

TO THE EDITOR:

One cannot read Mr. Cochrane's paper[7] without appreciating, probably as never before, how exacting a science welding is. Importance of design, materials, welding apparatus and supplies, fixtures, positioning machines, technique, and control is admirably pointed out. The opinion that a properly constituted weldery consists of purchasing welding equipment and hiring operators has passed out of the picture. Failures of that type of rule-of-thumb procedure, encountered years ago, still remain uppermost in many minds.

I wish to stress the importance of design. We know of the splendid developments of Mr. Cochrane's company in the building of large welded electric-generating equipment. Only because of the ability of its designing engineers to avoid prejudices in favor of older methods of construction were designs in welding that are stronger and lighter made possible. Through ingenious procedure control they have eliminated hundreds of hours of machine labor.

The importance of design is illustrated strongly in a development recently seen in building certain mechanical equipment. The problem was attacked by an engineer with no previous welding and mechanical-design experience but who was unprejudiced by past experience, and, having had considerable training in proper distribution of metal, developed a design that actually effected a saving of over $100,000 in total cost.

Progress in the next few years will depend greatly upon our ability to reduce weight and cost. Elimination of welding hours can be greatly increased by forming metal into the required shape by plate-bending brakes and presses, thus materially reducing the quantity of welding to be done.

The author has made two statements to which I must take exception. In one he mentions objectionable phosphorus content in steel. Developments of the newer low-alloy high-strength corrosion-resistant steels have resulted in several analyses incorporating upward of 0.12 to 0.14 per cent of phosphorus without objectionable physical, metallurgical, or welding properties. High-phosphorus steel has proved exceptionally desirable in resistance to corrosion.

The other statement is "since the human element in welding occupies a more important position than in the other trade lines, each man's ability must be determined before placing him on the job and periodic qualification or check tests or a training routine established to insure consistently good work from month to month." I agree with the foregoing requirements, but by inference I assume the author believes welding is a more exacting trade and one much more difficult to master than other shop trades. With this I cannot agree. Acquiring ability to operate large machine tools successfully in the author's plant requires experience ten times as extensive as is required to become a competent welder.

Mr. Cochrane's paper presents the exactness of welding requirements to produce the best America has to offer at competitive costs. The problem of the large plant, however, is not nearly so complex as in the smaller fabricating plant, many of which are doing splendid work, where one or two individuals must by necessity be metallurgists, research workers, and technique and control supervisors.

A. E. GIBSON.[8]

TO THE EDITOR:

Mr. Gibson's comments are welcome and appreciated. His interest, personal contributions, and experience in the welding field, and the excellent work done by his company in fabrication and design of intricate structures properly qualifies him as an authority on the subject.

The statement to which Mr. Gibson refers regarding the effect or necessary control of phosphorus in steel applies to welding or use of low-carbon steel as stated in a previous sentence of my paper. From a metallurgical standpoint, I believe it is generally recognized that, in a low-carbon steel, the phosphorus content, like sulphur, must be carefully controlled, 0.04 to 0.06 per cent maximum. We know that a plain low-carbon steel of 0.09 to 0.12 per cent phosphorus is inclined to be "cold short." Such physical properties obviously make the welding of such a material critical.

He is correct in stating that some of the low-alloy steels such as Cor-ten contain as much as 0.10 to 0.20 per cent phosphorus. This type of alloy steel also contains other elements that are not common to low-carbon steels such as increased silicon, chromium, and copper; the carbon content is also lower. In such a steel, the phosphorus is a necessary element and, in conjunction with the copper, does improve the corrosion-resistant properties of the material. Also, this type of alloy steel can be welded without any difficulty.

In the case of the last point mentioned by Mr. Gibson, I did not mean to infer that welding, as a trade, is more exacting than the operation of large machine tools. On the contrary, we know that in mastering welding, much less skill and experience is required even where the most versatile operator qualifications exist as compared with that necessary in the case of heavy machine tools. If we consider the finished job from the standpoint of quality and dependability I believe I can make my point clear. In machine-tool operation, whether it be a bench lathe, a milling machine, or a 60-ft boring mill, we can, through the use of gages and similar devices, accurately check

[6] Buensod-Stacey Air Conditioning, Inc., New York, N. Y.

[7] "Arc-Welding Practice in the Machine Shop," by A. G. Cochrane, MECHANICAL ENGINEERING, October, 1937, pp. 733–737.

[8] President, The Wellman Engineering Co., Cleveland, Ohio; and President, American Welding Society. Mem. A.S.M.E.

the finished part for dimensions, fits, and other variations that might affect operation of the finished apparatus. In welding operations, we have no similar positive means of insuring weld quality and soundness at our disposal today. X-ray, radiograph, and other similar nondestructive tests, where applicable, do this very satisfactorily but, on many jobs and on certain types of welded joint, such methods of testing are impracticable. With the above points in mind, it is obvious that, in welding large intricate structures where extreme welding versatility and changing job conditions exist, we cannot place too much emphasis on the human element in welding.

A. G. COCHRANE.[9]

Mr. Lockwood Straightens Things Out

TO THE EDITOR:

I received the December MECHANICAL ENGINEERING a couple of days ago and was pleased to find that you considered my report[10] of the meeting of the Swiss Society of Engineers and Architects of sufficient interest to reprint most of it.

Unluckily I find a couple of errors crept into it, the first of which I believe should be corrected if you see fit to do so.

Mr. Ph. Etter is Secretary of the Interior of the Swiss Republic, not Secretary of the Swiss Society. It was considered a great honor that he should greet the Engineers in the way he did. The very able Secretary of the Society is Mr. P. E. Soutter of Zurich.

The other error, not so important, is that we did not walk from Meiringen, a distance of 12½ miles, to Handegg Falls, but walked through the gorge of the Aare (not Vare) for a mile or so and then continued the trip to Handegg in the cars. As many members of the A.S.M.E. have been in Switzerland, some might think my report rather misleading.

FRANK A. LOCKWOOD.[11]

The Acoustic Ratio

TO THE EDITOR:

In reviewing the recent American Gas Association and The American Society of Mechanical Engineers reports on the decade of joint research conducted to establish better coefficients for the thin-disk orifice, some of us associated with the work have felt that in view of the relatively recent appearance (1929) of the acoustic ratio, it is desirable to indicate clearly that this useful operator was devised and first employed by Ed S. Smith, Jr., early in 1929. The almost simultaneous appearance of papers by Swift (in early October, 1929) and by Hodgson and Smith at the Tokio meeting of the World Power Conference (in October, 1929) left some doubt as to the real origin of the operator. Smith developed and presented it in concrete form at an opening meeting of the Fluid Meters Committee in Rochester, N. Y., on May 15, 1929.

The particular feature embodied in the acoustic ratio which renders it an improvement over the older operator, called the acoustic velocity ratio, is the manner in which the specific heat ratio is incorporated in the acoustic ratio, which makes it possible to coordinate research data on compressibility effects of gases of different composition in a single plot, similar to the manner in which viscosity effects are correlated by use of the Reynolds number.

R. J. S. PIGOTT.[12]
THOS. R. WEYMOUTH.[13]

Coal Selection for Steam-Generating Equipment

TO THE EDITOR:

Mr. Sherman's paper[14] is an interesting review of the present situation regarding coal selection and, more particularly, the factors involved. The apparent complications are evidenced by the many papers presented on the subject in recent years.

Although the author recognizes cost per unit output as being the final arbiter, he restricts his discussion to selection for satisfactory operation. Because of the wide range of ideas covered by the general nature of the paper, it would be invidious to pick on details.

In looking for a summarizing statement in the paper, it seems to be contained in its suggestion that the ideal should be for equipments that will burn any kind of coal. One would not accuse the author of believing that such a desirable solution would be economical. Rather it is legitimate to expect that, for equal satisfaction, investment in equipment should decrease with increase in cost of coal, but it is, of course, desirable that each type of equipment should include adjustments which will permit as wide a range of fuels as is economical. Advances in equipment design have been in that direction. In reading reports of coal-selection tests, one has wondered whether the operators have had enough fuel to permit of trying to find adjustments of the conditions that would overcome the undesirable features, that is, whether it might not have been possible to produce satisfactory operation by further trials.

Ability, on the basis of satisfactoriness, to select coals for a given use depends largely on a definite knowledge of the conditions to which they will be subjected in the furnace and how these conditions affect the coal. In a pulverized-coal furnace, conditions are relatively simple, and the sequence of events is predictable for quality and fairly closely for quantity. This holds also to a great extent for the spreader stoker. For these two types of furnace, the data on coals which we now have largely suffice, but the gap between relative satisfactoriness and cost per unit output will always involve some intangible factors and a choice that will require judgment.

Factors involved in a traveling grate are relatively few and largely controllable. Events in the sequences of burning are comparatively simple and predictable. Although data on ignition and effect of caking are yet missing, it should be possible to place selection for relative satisfactoriness on a fairly definite basis.

Actions in the multiple-retort type of underfeed stoker include the additional one that travel of the fuel is governed by several factors which include size, caking, and clinkering of the coal. These same properties also affect the distribution of air locally more than they do in other stokers. For this reason, selection by prediction based on properties of the coal cannot be assured, because the coal factors compound with each other and with the control by the stoker.

However, we must not deceive ourselves by believing that complete laboratory determination of all coal properties as numerical values, especially single ones, will make selection a simple process. Satisfactoriness of operation is a compound of coal properties, plant

[9] Superintendent, Arc Weld and General Screw-Machine Department, General Electric Company, Schenectady, N. Y.

[10] MECHANICAL ENGINEERING, December, 1937, p. 972.

[11] Veney, Switzerland. Mem. A.S.M.E.

[12] Staff Engineer, Gulf Research & Development Co., Pittsburgh, Pa. Mem. A.S.M.E.

[13] Vice-President, Columbia Gas & Electric Corporation, New York, N. Y. Fellow, A.S.M.E.

[14] "Status of Our Knowledge of Coal Selection for Steam-Generating Equipment," by R. A. Sherman, MECHANICAL ENGINEERING, November, 1937, pp. 829–834.

requirements, design and adjustments of the stoker, and the furnace.

Ability to predict results from a given set of premises is the main art, and this is the province of the combustion engineer. What is missing from the literature is how it can, is, or should be done. I fear that we attribute an omnipotence to them which is not justified. I have been urging that they put the process that they use on record for mutual training of themselves and accumulation of examples that are necessary for training the younger engineers. I am not suggesting that the process can be reduced to a simple formula, but because it is complicated is all the more reason why many concrete examples should be available. One must be able to explain the process of investigation and reasoning followed, must own that, in the main, he guesses, or must claim a God-given ability that cannot be put on paper.

I am referring more to the ordinary case where the work has to be done by one individual in a relatively short time, and not to those illustrated in the papers of Tobey and Tate.[15] Only by disclosing the lines of action and reasoning followed will it be possible gradually to get this art on paper. Again, I do not picture charts on which one can follow lines or columns to arrive at the answers but rather illustrative examples that, in time, will lead to coordination. Unless workmen are willing to help in collecting these data, they would seem to be unfair in complaining about the grade of tools provided for them. I presume to claim the friendship of the combustion engineer, and it is permissible for me to chide him.

The paper suggests that rate of burning be made a distinct characteristic of coal. If this were done, it would have to be associated with definite test conditions as the numerical values depend on them. One can get marked differences with coals because of the effect of caking. A table

TABLE 1 GASIFICATION RATES OF VARIOUS COALS

Coal seam	Gasification rate, lb per sq ft per hr
High Splint	4.13
Middle Kittanning	2.81
Pittsburgh B	2.27
Pocahontas No. 3	2.01
Thick Freeport	1.95

for values of this type is given on p. 147

[15] "Underfeed Stokers From the Standpoint of Coal Selection," by J. E. Tobey, Trans. A.S.M.E., vol. 60, 1938, paper FSP-60-4, pp. 17–24; and "Selection of Coal for Pulverized Firing," by R. E. Tate, Trans. A.S.M.E., vol. 60, 1938, paper FSP-60-3, pp. 11–16.

of the Bureau of Mines Bulletin No. 404. One set of values for strictly similar imposed conditions of test is given in Table 1.

The bed was not disturbed and consequently caking materially affected the burning. One set of single values of this type might be deceptive. They are a measure of caking for the imposed conditions, but relative values would decrease at higher air rates or for thinner firings.

P. NICHOLLS.[16]

TO THE EDITOR:

After a careful reading and study of Mr. Sherman's paper, I cannot hope to add much. It is most complete and informative and is a real contribution to our information on the subject. I concur with him in the statements that he makes and the conclusions of his paper.

Undoubtedly, lack of knowledge as to the various factors and lack of literature bringing together in a convenient form the knowledge that is available are the two principal difficulties in selecting coal for steam plants. After all, a great part of the problem of selecting coal for a steam plant is one of engineering and it will not be solved by any general rule or formula. Too often, the engineer, particularly in small plants, is not brought into the question. Some plant official, whose training has been in other lines, is entrusted with the coal problem. A formula, method, or plan of selection of coal can be worked out for almost any steam plant if a competent combustion engineer is called in and given an opportunity to study the problem.

So many factors, however, enter into this problem that it is not a simple one and it is not to be wondered at that user and equipment manufacturer do not have the knowledge, as the paper points out. The coal producer may have it and he may have an excellent combustion engineer, but the producer's job is to sell the coal that he produces and his engineer's job is to overcome the customer's difficulties and make the coal work in the best possible manner at the consumer's plant.

An old saying, "A salesman must sell or he doesn't eat," applies equally as forcibly to the coal producer. I am not trying to condone bad selling. All coal producers want to sell a consumer a fuel that will give good results, but you can hardly expect him to suggest a coal of a competitor which might do a little better job. The business is too highly competitive for that. So often lack of knowledge is really lack of a willingness to use available knowledge, no matter what the reason.

The paper refers to the American Society for Testing Materials Standards on Methods of Testing Coals. Difficulties of accurate sampling and of getting check results are great and a considerable allowance for possible error must be made, which has a tendency to create distrust of analysis. That this difficult problem is getting attention, as Mr. Sherman pointed out, is fortunate, and, undoubtedly, the number of tests necessary in finding the right coal can be reduced by the use of available information, meager as it is. It seems almost inexcusable for any engineer who has such important matters under his charge not to be a member of his engineering society and not to be well-read on this subject. After all, not much can be done for him that has eyes and sees not, has ears and hears not. I do not mean that the information should not be made more available by booklets and manuals such as the American Society for Testing Materials is having prepared. We greatly need it in more available form and I heartily endorse their efforts.

I notice the author used the word "coking." Recently, at a meeting of the Metropolitan Section of The American Society of Mechanical Engineers, I listened to a discussion o the meaning of "coking" and "caking." It was evident that no clear distinction is made in using these two words and it might be well for some one of the engineering societies to have them defined for use in connection with steam coal.

In speaking of the difficulty from coke trees and the use of a fuel-bed agitator in connection with small stokers, Mr. Sherman neglected to mention that some success in overcoming this difficulty has been attained by use of moving grates. At least two residential-size stokers have been marketed in the last few years which used a moving grate to overcome this difficulty. One is being pushed at present which uses a revolving grate and an ash-removing conveyor. I am informed that a large number of this model are giving entire satisfaction on a hard-coking coal.

The undertaking in the large plant of the Consolidated Edison Company of New York as described in the paper is a significant one and the company de-

[16] Supervising Fuel Engineer, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa. Mem. A.S.M.E. Mr. Nicholls' discussion is published by permission of the Director, U. S. Bureau of Mines.

TABLE P-8 ALLOWABLE STRESSES FOR FERROUS

PLATE STEELS

Type of Material	Low Carbon	Low Carbon	Carbon	Silicon Killed Carbon	Silicon Killed Carbon	2-2.75 Nickel	High Tensile Carbon, S-26, S-27, A149-36,	Carbon Molybdenum	2-2.75 Nickel	High Tensile Carbon, S-26, S-27, A149-36,	Carbon Molybdenum	2-2.75 Nickel	C.M.S.	Carbon Molybdenum
A.S.M.E. Specification	S-2	S-2	S-1										S-28	
A.S.T.M. Specification	A89-33	A89-33	A70-36	A201-37T	A201-37T	A203-37T	A150-36	A204-37T	A203-37T	A150-36	A204-37T	A203-37T	A202-37T	A204-37T
Grade or Analysis	Grade A	Grade B		Grade A	Grade B	Grade A	Grade A	Grade A	Grade B	Grade B	Grade B	Grade C	Grade A	Grade C
Minimum Tensile Strength	45000	50000	55000	55000	60000	65000	65000	65000	70000	70000	70000	75000	75000	75000
Metal Temperatures, deg F														
—10 to 650	9000	10000	11000	11000	12000	13000		13000	14000		14000	15000		15000
675	8800	9800	10800	10800	11800	12700		13000	13700		14000	14700		15000
700	8500	9500	10400	10400	11400	12300		13000	13300		14000	14100		15000
725	8200	9000	9800	10000	11000	11800		13000	12600		14000	13300		15000
750	7800	8500	9200	9500	10400	11100		13000	11900		14000	12400		15000
775	7400	8000	8600	9000	9800	10300		13000	11000		14000	11200		15000
800	6900	7500	8000	8500	9100	9400		13000	10000		14000	10100		15000
825	6300	6800	7200	7900	8300	8500		12250	8900		13000	8900		13750
850	5700	6000	6300	7200	7400	7600		11500	7800		12000	7800		12500
875	5100	5300	5400	6400	6500	6600		10750	6700		11000	6700		11250
900	4400	4400	4400	5600	5600	5600		10000	5600		10000	5600		10000
925	3500	3500	3500	4700	4700	4700		9000	4700		9000	4700		9000
950	2600	2600	2600	3800	3800	3800		8000	3800		8000	3800		8000
975	Note 1	Note 1	Note 1	2900	2900	2900		6500	2900		6500	2900		6500
1000	Note 3	Note 3	Note 3	2000	2000	2000		5000	2000		5000	2000		5000

Carbon steel materials covered by Boiler Code specifications and/or grades of same, which are not included in these tables, are limited to use at temperatures of from —10 to 650 F. The allowable stress in wrought materials is one fifth of the ultimate; and in cast materials, one seventh of the ultimate.

Note 1: Firebox or flange up to 850 F. Above 850 F firebox only.
Note 2: Limited to 750 F.
Note 3: Limited to 950 F.
Note 4: Silicon limitation not given in specification. If allowable stresses given in this column are used silicon must be within the range shown.

serves the appreciation of all concerned for their generous cooperation.

It is entirely true that "to produce any considerable effect in the elimination of waste fuels, we must look to improved average practice rather than to our best records." But, I, for one, like to see records and see them have the widest possible publicity. They are the stimulators that cause the great average class to strive for better things.

JOHN C. COSGROVE.[17]

TO THE EDITOR:

Mr. Nicholls has pointed out that the ideal fuel-burning equipment for which the writer asked in his paper would probably not be economical. That is granted and it is not expected that the ideal will ever be fully attained, but the ideal should always be kept in mind and fuel-burning equipment should be designed to be as nearly universal as possible in its adaptability to various fuels.

Mr. Cosgrove has properly called attention to the writer's failure to mention the residential stoker operating on the principle of automatic ash removal that has had wide application in the last few years. It is an example, however, of a stoker that is designed for a particular coal, semibituminous, and its use is restricted to that coal. It is understood, however, that the stoker has on occasion successfully burned high-volatile coals and it is to be hoped that the manufacturers may see fit to make it available for use with a wider variety of coals.

The terms "caking" and "coking" have been clearly defined in the literature, but, as Mr. Cosgrove says, they are often loosely and incorrectly used. As concerned with combustion in fuel beds, the meaning of the terms to the writer is as follows: Caking characteristics of a coal govern the nature of the plastic state through which a coal passes as it is being carbonized in the fuel bed. A strongly caking coal may become so plastic that the original identity of the pieces of coal is lost and the entire mass of coal melts into a cake. Coking characteristics of a coal govern the degree of strength of the final resultant coke in the fuel bed. For example, a coal of the Pocahontas type would not be classed by the writer as a strongly caking coal as it does not pass through an extremely plastic state while being carbonized; it is, however, strongly coking because the resultant coke has great strength. Some coals, as from the Pittsburgh seam, are strongly caking as they pass through a molten state of low viscosity in the formation of coke. The coke generally formed is strong but its strength may not be so great as that from the Pocahontas coal. The Pittsburgh coal might, therefore, be more strongly caking but less strongly coking than the Pocahontas coal.

RALPH A. SHERMAN.[18]

[17] President, Bituminous Coal Research, Inc., Johnstown, Pa.

[18] Supervisor, Fuels Division, Battelle Memorial Institute, Columbus, Ohio. Mem. A.S.M.E.

Allowable Working Stresses for Ferrous Materials

TABLE P-8 REVISED

THE Boiler Code Committee of The American Society of Mechanical Engineers proposes to revise the present allowable stresses for ferrous materials in accordance with the accompanying tables and curves, which tables and curves include proposed stresses for specifications now under consideration and are proposed to replace present Table P-8. The values proposed are based on the best experience and all data supplied to the Subcommittee on Ferrous Materials, including that furnished by the Special Committee on Assembly and Interpretation of Available Creep Data of the Joint A.S.T.M.-A.S.M.E. Research Committee on Effect of Temperature on the Properties of Metals.

The temperatures given are the maximum metal temperatures at the mid-point of the wall thickness, and the stresses set do not take into consideration any deductions for joint efficiency and are based on the strength of the material in a stress-relieved condition.

The proposed values cannot be proportionately adjusted for factors of safety of less than 5 on plate and forged material, and less than 7 on castings at temperatures above which the allowable values are reduced. The matter of setting allowable stresses for lower factors of

MATERIALS AT VARIOUS TEMPERATURES

PIPE AND TUBE STEELS										DRUM FORGINGS		FORGED FLANGES AND FITTINGS			CASTINGS		
Carbon S-18	Low Carbon S-32	Low Carbon S-17	Carbon S-40	Low Carbon S-18	Low Carbon S-17	Carbon Molybdenum	Medium Carbon S-32	Medium Carbon S-18	Medium Carbon S-17	S-4	S-4	Carbon S-8	Carbon S-8	Carbon Molybdenum S-35	Carbon S-11	Carbon S-12	Carbon Molybdenum S-33
A53-36 Lap-welded, Open-Hearth or Electric	A178-37 Grade A Not Silicon Killed	A83-36 Grade A Seamless Not Silicon Killed	A192-36T Seamless Silicon .10-.25 per cent	A53-36 Open-hearth or Electric Seamless Silicon .10-.25 per cent	A83-36 Grade A Seamless Silicon .10-.25 per cent	A206-37T P-1 Seamless	A178-37 Grade C Silicon .10-.25 per cent	A53-36 Open-hearth or Electric Seamless Silicon .10-.25 per cent	A83-36 Grade C Seamless Silicon .10-.25 per cent	Class 1 Silicon .15-.30 per cent	Class 2 Silicon .15-.30 per cent	A105-36 Class 1 Silicon .15-.30 per cent	A105-36 Class 2 Silicon .15-.30 per cent	A182-36 F-1	A27-36T Grade B and B2 Silicon .20 per cent min Note 4	A95-36	A157-36 C-1 Carbon .35 per cent max
45000	45000[a]	45000[a]	47000[a]	47000[b]	47000[a]	55000	60000	60000[b]	60000	Seamless 60000	Seamless 75000	60000	70000	70000	70000	70000	70000
9000	9000			9400		11000		12000		12000	15000	12000	14000	14000		10000	10000
8800	8800			9300		11000		11800		11800	14700	11800	13700	14000		9800	10000
8500	8500			9100		11000		11400		11400	14100	11400	13300	14000		9500	10000
8200	8200			8850		11000		11000		11000	13300	11000	12600	14000		9000	10000
7800	7800			8600		11000		10400		10400	12400	10400	11900	14000		8500	10000
	7400			8300		11000		9800		9800	11200	9800	11000	14000		7900	10000
	6900			7900		11000		9100		9100	10100	9100	10000	14000		7200	10000
	6300			7400		10750		8300		8300	8900	8300	8900	13000		6500	9400
	5700			6800		10500		7400		7400	7800	7400	7800	12000		5800	8800
	5100			6200		10250		6500		6500	6700	6500	6700	11000		5100	8300
	4400			5600		10000		5600		5600	5600	5600	5600	10000		4400	7800
	3500			4700		9000		4700		4700	4700	4700	4700	9000		3700	7200
	2600			3800		8000		3800		3800	3800	3800	3800	8000		3200	6700
				2900		6500		2900		2900	2900	2900	2900	6900			5700
				2000		5000		2000		2000	2000	2000	2000	5000			4600
Note 2	Note 3			Note 4				Note 4		Note 4	Note 4	Note 4	Note 4			Note 3	

[a] No ultimate tensile strength given in specification. The ultimate tensile strength given may be used for design.
[b] Use the ultimate tensile strength given for design—it is lower than that given in the specification.

safety is still in the hands of the committee.

Stresses for alloy materials covered by specifications in the Boiler Code which are not included in these tables and/or curves are still in the hands of the committee.

The following materials shall not be used for temperature service above 650 F. At 650 F to —10 F the allowable stresses shall be one fifth of the ultimate for forged and rolled material, and one seventh of the ultimate for cast materials:

Specification S-17, Grade A, lap-welded
Specification S-17, Grade B, lap-welded
Specification S-18, acid bessemer, lap-welded
Specification S-19
Specification S-32, Grade B, open-hearth iron
Specification S-25, open-hearth iron plates.

The accompanying proposed revision is submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets.

Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the A.S.M.E. Boiler Code Committee for consideration.

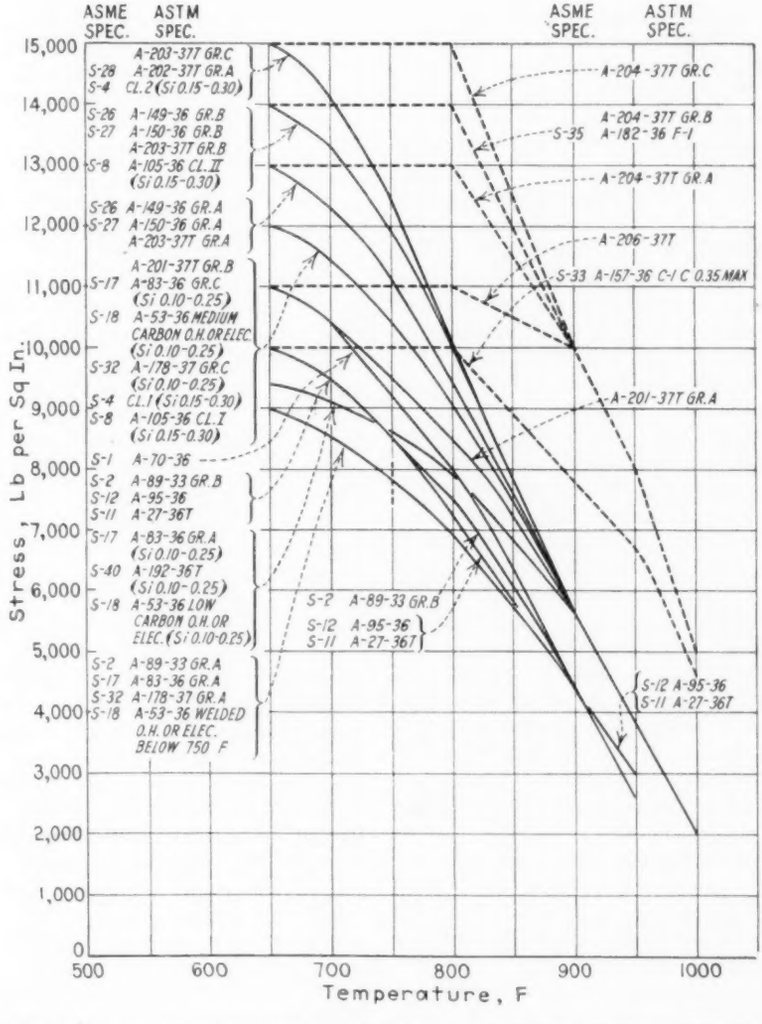


FIG. P-7K DIAGRAM FOR DETERMINATION OF ALLOWABLE WORKING STRESSES GIVEN IN TABLE P-8

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Famous Engineers

GROSSE INGENIEURE, LEBENSBESCHREIBUNGEN AUS DER GESCHICHTE DER TECHNIK. By Dr. Conrad Matschoss. J. F. Lehmann, Munich. Cloth, 6 × 9 in., 334 pp., illustrated. $2.52.

REVIEWED BY J. K. FINCH[1]

CONTRARY to current popular belief, engineering is not a recently developed profession but, as Dr. Matschoss points out, its history extends back over a period of some 50 centuries. In his recent work, this distinguished German historian of engineering has endeavored to choose, from a profession that is thus as old as civilization itself, a representative group of great engineers. He has, from the nature and scope of his problem, been forced to limit his choice. As he observes in the preface, selection of the engineers to be included in the book was difficult and "it is evident that many great men have been omitted whose lives form an important part in the story of engineering." This fact becomes clear when we note that the book does not attempt to cover civil engineering but is confined primarily to the mechanical engineers and industrial and manufacturing experts. Dr. Matschoss hopes at a future date to publish a similar work on the men who build, as he says, highways, canals, bridges, and tunnels.

When one recalls that, until comparatively recent times, the only recognized branches of engineering were civil and military, this limitation obviously leaves some tremendous historical gaps in the present work and does not give it the balance that a more comprehensive treatment would preserve. Beginnings of mechanical work can, of course, be traced far back to the simple tools and machines of Egyptian and later ages. The great growth of the manufacturing and power branches of the profession, however, came only with the development and application of steam power in the late eighteenth and nineteenth centuries. One gets the impression, therefore, that little engineering was done until comparatively recent times, if the long intermediate era in which civil-engineering work predominated is omitted.

Over two thirds of this volume, because of this limitation, is devoted to the more recent progress in mechanical engineering. Beginning with the British pioneers of the age of steam power and the machine and tool builders, whose work was also basic to the Mechanical Revolution, Dr. Matschoss carries the story down to such moderns as Diesel, Edison, and Westinghouse. In its earlier parts, it includes much that is already available to the American reader in our own Professor Roe's monumental "English and American Tool Builders" and in the famous "Lives of the Engineers" by Smiles.

It is, as Dr. Matschoss observes, "easy to make a long list of distinguished men who are not included in this book," and such a criticism would be unfair in view of the difficulties and limitations that the author notes in his preface. Perhaps the most that should be said is that the balance between the unimportant and the distinguished is not one with which the reviewer would be in full accord.

A most glaring lack of balance, for example, is the omission of the French workers in the mechanical field. For the two or three centuries between the culmination of the Italian Renaissance and the development of the Mechanical Revolution in Great Britain, the French were acknowledged leaders in engineering. Yet this fact seems to be completely ignored by Dr. Matschoss. It is, of course, true that this leadership was primarily in what we now know as the civil-engineering field, a field not covered, as we have noted, in this work. Nevertheless, one finds no mention here of Besson's famous "Theatrum Instrumentorum et Machinarum" or of Ramelli's classic, "Le Diverse et Artificiose Machine." The great French tool and instrument makers are passed over, while that "forest of wood and iron," the great machine of Marley, although one of the mechanical wonders of the world of its day, is, apparently, forgotten.

Yet we need more books of this kind, if only to give us some perspective of our profession and some idea of the part that it has played in the development of Western civilization. The American printer also may look with profit on this recent example of German printing. The presswork in general, the attractive but practical binding, and, particularly, the excellence of the half-tone illustrations are worthy of special note.

[1] Renwick Professor of Civil Engineering, Columbia University, New York, N. Y.

Weather Forecasting for Aerial Transportation

SYNOPTIC AND AERONAUTICAL METEOROLOGY. By Horace Robert Byers. McGraw-Hill Book Company, Inc., New York, N. Y., and London. Buckram, 6 × 9 in., 279 pp., $3.50.

REVIEWED BY EDWARD J. MINSER[2]

AN accurate knowledge of the weather present and future, is of paramount importance to the air-transport operators. It is, therefore, to be expected that a suitable book covering this subject should be written by a meteorologist who has been closely allied with that industry. The author's experience and training are evident in the practical treatment of the subject, for aviators, as practical men, demand practical methods, theory and experimentation being left to other branches of aeronautical science.

Weather forecasting based on the principles of air-mass analysis first received recognition in the United States by the U. S. Navy and those air lines maintaining their own meteorological services. Its adoption by the U. S. Weather Bureau immediately created a demand for written treatises on the subject. These have been few in number and are, in general, academic or foreign publications, overflowing with mathematics. Neither continuity nor practical application of subject matter can be found in these various texts, and, therefore, this book fills a long-felt need by assembling under one cover a comprehensive treatise of the application of modern meteorology to forecasting.

"The modern application of the principles of physical hydrodynamics to the weather has given conclusive evidence that the vertical components of air motions are the principal factors in producing the more important meteorological phenomena," states the author. This first principle of air-mass analysis

[2] Chief Meteorologist, Transcontinental & Western Air, Inc., Kansas City, Mo.

is followed throughout the text, the application of the various principles of thermodynamics and physics to weather processes being accomplished with minimum mathematical explanation.

The forecasting of weather is based upon the weather map and, as "synoptic meteorology is the study of the weather conditions over a large area at a given instant," ample space is devoted to the weather map and forecasting, descriptions of various phenomena being based on actual map analysis or by similar practical treatment.

Primarily published for the aviator, the last third of the book is devoted to those phenomena of greatest importance to flying; condensation and precipitation, fog, thunderstorms, ice, turbulence, upper-air winds, and dust storms. Physical processes involved in the production of these atmospheric conditions must be understood if they are to be forecasted accurately or avoided in flight. The reader is fully acquainted with physical conditions necessary for formation of specific weather phenomena, changes involved as various influences are brought in play, and eventual dissipation with change or loss of sustaining forces. Analysis of actual synoptic situations is used to demonstrate application of fundamental theory, but ideal situations are held to the minimum, lest a tendency to consider them as common occurrences, develop, something that every forecaster sooner or later learns to his sorrow is not the case. This idea is evident throughout the book, emphasis being given to the fact that meteorological phenomena are subject to many diverse and minute influences which determine the type of weather resulting from a combination of certain primary conditions of temperature, pressure, and water vapor.

Having forsaken mathematics as a means of explaining complex physical processes, the author is forced to take certain liberties of description that may be questioned by theoretical meteorologists. He is also frequently forced to choose between conflicting theories. However, these factors do not detract from the utility of the book but rather tend to clarify problems that have puzzled the practical man. In so doing, the author performs a great service for the science.

Books Received in Library

A.S.T.M. STANDARDS ON TEXTILE MATERIALS, Prepared by Committee D-13 on Textile Materials. American Society for Testing Materials, Philadelphia, September, 1937. Paper, 6 × 9 in., 306 pp., illus., diagrams, charts, tables, $2; $1.25 to A.S.T.M. members. In this single pamphlet appears all the important material on methods of testing, definitions, terms, and specifications for textile materials, developed by the American Society for Testing Materials.

AIRCRAFT PROPELLER HANDBOOK. By K. H. Falk. Ronald Press Co., New York, 1937. Cloth, 6 × 9 in., 99 pp., diagrams, charts, tables, $4. Concise, practical data for propeller design, covering static, gyroscopic, and aerodynamic characteristics, twisting movements, vibration, and strength. There is a large chapter giving examples of calculations, and a section on the selection of propellers.

AIRPLANE MAINTENANCE. By J. H. Younger, A. F. Bonnalie, and N. F. Ward. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 9 in., 353 pp., illus., diagrams, charts, tables, $3. Practical information on airplane materials and the construction of airplanes and their parts. Covers repair-shop equipment and methods, servicing, testing, etc., with special attention to thin-sheet-metal airplanes. Each chapter has examples of actual jobs, review questions, and references. Intended for repair-station mechanics and operators.

APPLIED PHOTOGRAMMETRY. By R. O. Anderson. Edwards Brothers, Ann Arbor, Mich., 1937. Paper, 6 × 9 in., 120 pp., illus., diagrams, charts, tables, $2. This manual gives methods for determining the correct scales of aerial photographs, together with an analytical radial-line method of control, taking into account both relief and tilt. It aims to facilitate the simple, practical, and accurate application of aerial photography to various types of surveys.

BEITRAG ZUR UNTERSUCHUNG DER FACHWERKE AUS GESCHWEISSTEN STAHL UND EISENBETON UNTER STATISCHEN UND DAUERBEANSPRUCHUNGEN, by S. A. Mortada. Eidg. Materialprüfungsanstalt an der E.T.H. in Zurich. Bericht Nr. 103. October, 1936. Paper, 8 × 12 in., 98 pp., illus., diagrams, charts, tables. Describes an extensive experimental investigation of the behavior of welded-steel and reinforced-concrete girders under static and fatigue strains. The theoretical principles are described, the methods of testing and the results are discussed. The conclusions are summarized in French, Italian, and English.

CENTRAL STATIONS. By T. Croft. Reviewed by G. H. Hall. Third edition. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 8 in., 360 pp., illus., diagrams, charts, tables, $3. A revised edition of a practical manual for the central-station electrician which has been widely popular. In addition to a nonmathematical presentation of scientific fundamentals, it discusses all phases of generation, transmission, and distribution, as practiced today. New material has been added in networks, turbines, protective apparatus, voltage regulators, and other topics.

COLLECTIVE BARGAINING IN THE STEEL INDUSTRY: 1937. By F. H. Harbison. Princeton University, Princeton, N. J., Industrial Relations Section, Sept., 1937. Paper, 8 × 11 in., 43 pp., tables, $1. The product of analysis and field work, this report presents the material as collected, no conclusions being drawn. Main headings are the provisions of union agreements, the steel-workers' organizing committee and the reaction of management to its recognition, and the employee representation. The Carnegie-Illinois Steel Corporation agreement with the S.W.O.C. is included as an appendix.

COST ACCOUNTING, Principles and Methods. By C. Reitell and C. E. Johnston. Second edition. International Textbook Co., Scranton, 1937. Cloth, 6 × 10 in., 425 pp., charts, tables, $3.50. To show that costing for distribution expense is as essential as manufacturing costs is the principal purpose of this revised edition. Following sections on basic-cost principles and manufacturing-cost elements come three sections covering process and job-order cost systems, standard costs and budgets, and executive use of costs.

(A) CRITICAL ANALYSIS OF THE FUEL MANAGEMENT PROGRAM FOR SCHOOLS. (Teachers College, Columbia University Contributions to Education, No. 713.) By A. M. McCullough. Teachers College, Columbia University, New York, 1937. Cloth, 6 × 9 in., 141 pp., charts, diagrams, tables, $1.85. The results of an intensive study of the heating of schools in eight New Jersey cities (and comparison with best practices elsewhere) have been utilized in an analysis made in terms of three major fields: purchase, delivery, and storage of fuel; conversion of fuel into heat units; and the distribution of heat. It is hoped that the suggested program will enable school administrative bodies to strike the proper balance between fuel economy and efficient heating procedure.

DIE DAMPFKESSEL. By A. Loschge. Eighth edition. Julius Springer, Berlin, 1937. Cloth, 6 × 9 in., 424 pp., illus., diagrams, charts, tables, 24 rm. This book is a modern text replacing the well-known one of Tetzner-Heinrich. The work is intended for use in engineering universities, and as a reference work, in which theory and construction are both given equal treatment. After an introductory discussion of the scientific principles involved, special attention is given to modern knowledge of the heat phenomena in boilers and furnaces, and its application to design. Special matters are discussed including auxiliary equipment. Finally, complete calculations for two types of boilers are given as examples.

DIFFERENTIALGEOMETRIE, Vol. 1. Raumkurven und Anfänge der Flächentheorie. (Sammlung Göschen Nr. 1113.) By R. Rothe. Walter de Gruyter & Co., Berlin and Leipzig, 1937. Cloth, 4 × 6 in., 132 pp., diagrams, tables, 1.62 rm. Space curves and the origins of surface theory are the subject of this first volume of a series on differential geometry. Material covered includes the analytical construction of space curves and surfaces, tangents, warped surfaces, differential invariants, line elements, cutting angles, and various basic equations.

DAS FERNROHR. By C. Münster. Deutsches Museum, Jg. 9, Heft 4. Berlin, V.D.I. Verlag, 1937. Paper, 6 × 8 in., 108 pp., illus., diagrams, charts, tables, 90 rm. The subject of this small pamphlet is the telescope. The first section covers the optical characteristics which are the basis of its operation, and the

latter part describes the mechanical characteristics of various types of telescopes.

GRINDING PRACTICE. By F. H. Colvin and F. A. Stanley. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 9 in., 310 pp., illus., diagrams, charts, tables, $3. A comprehensive practical manual for the shopworker, shop executive, and planner, covering the field of modern grinding machines and abrasive wheels; showing what they do, how to operate them, and their use for various types of work. Contains information on speeds, feeds, precision grinding, automatic machines, etc.

HEAT AND THERMODYNAMICS. By M. W. Zemansky. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 9 in., 388 pp., diagrams, charts, tables, $4. An intermediate textbook for students preparing for a career in theoretical physics, theoretical chemistry, or engineering. The first ten chapters deal with fundamental ideas of heat, reversibility, entropy, etc. The remaining nine chapters deal with physical, chemical, and engineering applications of these principles to specific cases. Problems are included with each chapter.

HEATING, VENTILATING AND AIR CONDITIONING FUNDAMENTALS. By W. H. Severns. John Wiley & Sons, New York, 1937. Cloth, 6 × 10 in., 467 pp., illus., diagrams, charts, tables, $4. A presentation of the essential fundamentals of heating, ventilating, and air conditioning in not too technical language. There are also included detailed discussions of modern methods of handling problems in these fields.

HOOVER POLICIES. By R. L. Wilbur and A. M. Hyde. Charles Scribner's Sons, New York, 1937. Cloth, 6 × 10 in., 667 pp., tables, $3. Mr. Hoover's governmental policies are presented by two members of his cabinet. The list of subject headings includes social, labor, agriculture, tariff, conservation, public works, business regulation, banking reform, and foreign policies; also a section on the depression and relief methods. An exhaustive index is included.

THE INGOT PHASE OF STEEL PRODUCTION. By E. Gathmann. Catonsville, Baltimore, Md., 1937. Cardboard, 7 × 11 in., 76 pp., illus., diagrams, tables. A survey of the period in steel production which embraces the operations involved from the finishing of the heat, through teeming, solidification, and reheating of the ingot, to the initial working in the mill. Describes new and important practices and details leading to soundness and relative homogeneity in the ingots, which characteristics are the foundation of good steel products.

INTRODUCTION TO MATHEMATICAL PROBABILITY. By J. V. Uspensky. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 9 in., 411 pp., tables, $5. This textbook, the outgrowth of lectures at Stanford University, is intended to give students the fundamentals of the theory of probability and a fairly comprehensive statement of its more important methods and results.

AN INTRODUCTION TO PROJECTIVE GEOMETRY. By C. W. O'Hara and D. R. Ward. Clarendon Press, Oxford, England; Oxford University Press, New York, 1937. Cloth, 6 × 9 in., 298 pp., diagrams, $4. An elementary account of the fundamental concepts and methods of projective geometry in two dimensions, both synthetic and algebraic. Following the propositions of incidence of lines and points, and projective coordinates, the authors demonstrate the relation to the various metrical geometrics and the special theory of relativity.

INTRODUCTION TO THE THEORY OF FOURIER INTEGRALS. By E. C. Titchmarsh. Clarendon Press, Oxford, England; Oxford University Press, New York, 1937. Cloth, 6 × 10 in., 390 pp., tables, $6. A systematic account of the elements of the theory of Fourier integrals. In the early chapters Fourier's integral formula and associated formulas are proved under various conditions, and Plancherel's theory of Fourier transforms and its extensions are given. The theory of conjugate functions, self-reciprocal functions, and general transformations of the Fourier type follows. Applications are then made to the evaluation of definite integrals and to the solution of certain differential and integral equations.

KRAFTFAHRTECHNISCHE FORSCHUNGSARBEITEN, Heft 9, 1937. V.D.I. Verlag, Berlin. Paper, 8 × 12 in., 35 pp., diagrams, charts, tables, 5 rm. Investigations of gas producers and purifiers for vehicle operation. Covers the use of solid fuels, descriptions of the various types of installations, test procedures, test results, and a discussion of these results in regard to motor output, producer lag and capacity, and gas production.

PHYSICS IN INDUSTRY. American Institute of Physics, New York, 1937. Cloth, 5 × 8 in., 290 pp., illus., diagrams, charts, $1.50. A collection of interesting articles by industrial physicists which demonstrate the importance of physical training and research in various large industries, together with two articles on the "training of physicists for industry" from the viewpoint of the educator and the employer, respectively.

REGELN FÜR ABNAHMEVERSUCHE AN DAMPFKESSELN, VDI-DAMPFKESSEL-REGELN, DIN VDI, 1942. V.D.I. Verlag, Berlin, 1937. Paper, 8 × 12 in., 16 pp., tables, diagrams, 3.50 rm. Rules for acceptance tests for steam boilers (V.D.I. standards). The conditions, apparatus, and methods of test are described, and the value of the test is explained. An appendix deals with the fuels used in such tests.

1937 SUPPLEMENT TO BOOK OF A.S.T.M. STANDARDS. American Society for Testing Materials, Philadelphia, 1937. Paper, 6 × 9 in., 272 pp., illus., diagrams, charts, tables, $2 (free to purchasers of copies of Standards). Forty-four standards (new, replacements, or revisions), adopted since the appearance of the 1936 edition of the triennial Book of Standards, are published in this Supplement.

SYMPOSIUM ON WEAR OF METALS. American Society for Testing Materials, Philadelphia, 1937. Paper, 6 × 9 in., 105 pp., illus., diagrams, charts, tables, $1.25. The six papers included cover wear testing of metals, important variables encountered in wear tests on cast iron, and the wear of metals from the viewpoint of four different fields, automotive, power equipment, textile, and railroad.

VDI-FORSCHUNGSHEFT 386. BEITRÄGE ZUR KENNTNIS DER GLEITLAGERREIBUNG. By G. Vogelpohl. V.D.I. Verlag, Berlin, Sept.-Oct., 1937. Paper, 8 × 12 in., 28 pp., illus., diagrams, charts, tables, 5 rm. A mathematical treatment of friction in sliding bearings. Equations and diagrams pertaining to lubricating films, minimum bearing friction, energy and temperature conditions in flat sliding wedges, and semifluid friction are given, and experiments with a bearing flow model are described. Lists of symbols and references are included.

VENTILATOREN. By B. Eck. Julius Springer, Berlin, 1937. Leather, 6 × 10 in., 197 pp., illus., diagrams, charts, tables, 13.50 rm. Centrifugal and screw blowers are treated in this volume. Section A covers flow theory, blade design, efficiency, operating characteristics, and the principal dimensions of radial blowers. Section B covers the same ground for screw blowers. Sections C and D cover constructional types and characteristic diagrams respectively for both kinds.

VERSICHERUNGSMATHEMATIK, Vol. 1. (Sammlung Göschen Nr. 180.) By F. Böhm. Second edition. Walter de Gruyter & Co., Leipzig and Berlin, 1937. Cloth, 4 × 6 in., 151 pp., tables, 1.62 rm. This small first volume of a series on actuarial mathematics covers the subject of interest rates, mortality tables, and premium costs as calculation bases, premium reserves, and joint policies.

DAS WIRTSCHAFTSGANZE IM BLICKFELD DES INGENIEURS. (Schriftenreihe Ingenieurfortbildung.) By O. Goebel. Julius Springer, Berlin, 1937. Paper, 6 × 9 in., 111 pp., 4.80 rm. A discussion of the general economic system from the viewpoint of the engineer. Various economic theories are propounded, and the effect of scientific development on political, social, and industrial economy is described.

UTILISATION OF ELECTRIC ENERGY. By E. O. Taylor. D. Van Nostrand Co., New York, 1937. Cloth, 6 × 9 in., 342 pp., illus., diagrams, charts, tables, $6. This book aims to cover the whole range of the more usual applications in a single volume and in a manner suitable for a student or an engineer who does not specialize in any branch. Electric drive, electric traction, heating and welding, electrolytic processes, illuminating engineering and economic topics are discussed, with emphasis upon principles rather than practical details of construction.

V.D.I. WASSERDAMPFTAFELN mit einem Mollier (i, s)-Diagramm auf einer besonderen Tafel. By W. Koch. R. Oldenbourg and Julius Springer, Munich and Berlin, 1937. Cardboard, 8 × 12 in., 64 pp., tables, 7.50 rm. These new steam tables and the Mollier diagram are based upon the latest conclusions of International Steam Table Conference.

WÄRMETECHNISCHE BERECHNUNG DER FEUERUNGS- UND DAMPFKESSEL-ANLAGEN. By F. Nuber. R. Oldenbourg, Munich and Berlin, 1937. Paper, 4 × 7 in., 155 pp., diagrams, charts, tables, 3.80 rm. This small manual on steam-boiler-plant calculation is divided into four parts. The first discusses combustion, flue gases, temperatures and heat loss, fuel consumption, and heat balance. The second takes up heat transfer, heating surfaces, flues, chimneys, and blowers. The third covers regeneration, high-pressure steam, examples of calculations, heat economy, feed and boiler water, and new developments in boiler plants. Part 4 includes tables and diagrams for use in calculations.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Los Angeles Spring Meeting Program Far Advanced

Organized Tour, Excellent Technical Papers, Inspection Trips, Entertainment, and California Sunshine Promise Well-Attended, Successful Meeting

AT THE TIME of going to press plans for the A.S.M.E. Spring Meeting at Los Angeles, Calif., March 23 to 25, 1938, show 15 papers definitely assigned to sessions, a remarkable response to the tour, announced on page 95 of the January issue, a well-arranged program for the women in attendence, inspection trips in abundance, a special Hollywood visit, and an "Old Timers' Meeting."

The Papers

Lined up under subject headings the papers are as follows:

Aeronautics

The Douglas Company's Hydraulic Press and the Guerin Process

Maximum Economy in Air Transportation

Applied Mechanics

Fluid Problems of Ocean Circulation

Fuels

The Technique of Burning Fuel Oil and Natural Gas

Combination Oil and Gas Burners

Hydraulics

Centrifugal Pumps for the Colorado River Aqueduct

Cavitation of Centrifugal Pumps Described by Similarity Considerations

Deep-Well Pump Testing Laboratory at the University of California

The Hydraulic Jump in Slope Channels

Kaplan Turbines at Bonneville

Spillway Gates at Bonneville

Petroleum

Progress in Deep-Well Drilling

Progress in Deep-Well Pumping

Santa Maria and Summit Pump Stations

Power

Voltage Standardization and System Frequency Change from 50 to 60 cycles by the Bureau of Power and Light, City of Los Angeles

Miscellaneous

Mechanical Problems in the Design of Diesel Tractors

Mechanical Problems in the Design of the 200-Inch Telescope

Heat-Transfer Research at the University of California

While the papers listed are impressive, the Professional Divisions are still actively at work and in addition to the foregoing the following papers are being considered to appear in the final program: Airplane Vibration Problems, Cavitation in Impulse-Wheel Nozzles, Modern Hydraulic Governors, Pressure Pipe Thermometer Systems, Pyrometers, Orchard Heating, and Filtration.

High Spots of Program

The program "at a glance" looks like this:

WEDNESDAY, MARCH 23

Morning

Technical papers on Hydraulics, Petroleum, Process.

Afternoon

Inspection trips to Motion-Picture Studios and Laboratories including RCA Recording Plant and Walt Disney Studio.

Evening

Program showing the complete process of making a motion picture from the editing of the original script to the finished picture with sound effects added. This will be an extraordinary occasion, as this demonstration is seldom given.

Dinner in Hollywood with local entertainment.

THURSDAY, MARCH 24

Morning

Technical Papers on Hydraulics, Fuels, Aeronautics.

Afternoon

Inspection trips to Douglas Airplane Plant, Kobe, Inc., (makers of deep-well oil pumps and flame-cut well screen), and Mt. Wilson Shops and Observatory.

Evening

Technical Papers on Management, Petroleum, Hydraulics.

Galloway, N. Y.

THE NEW LOS ANGELES LIBRARY

FRIDAY, MARCH 25

Morning

Technical Papers on Hydraulics, Applied Mechanics, Miscellaneous Subjects.

Afternoon

Inspection trips to oil fields, California Institute of Technology Pump Laboratory, 200-Inch telescope, local steam and Diesel plants.

Evening

Banquet, with address by President Harvey N. Davis. Entertainment and dancing.

Women's Program

A special program has been arranged for the entertainment of the women attending the meeting.

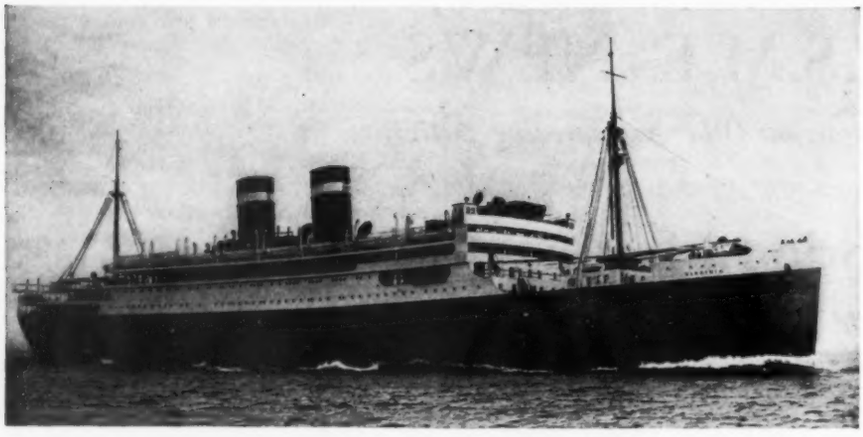
WEDNESDAY, MARCH 23

Morning

Informal get-acquainted session at headquarters, with luncheon at the Hotel Biltmore

Evening

The motion-picture events on the main program are of such interest that every one will probably wish to attend, so no other entertainment has been planned.



S. S. "VIRGINIA"—THE CRUISE SHIP

THURSDAY, MARCH 24

Morning and Afternoon

Auto trip through the Orange Grove Section and foothill cities to Padua Hills for luncheon. Talented young Mexican artists act as waitresses and entertain with their colorful dances and music. After a brief visit to the interesting shops, the party will stop at the Huntington Library on the return trip. The priceless collection of porcelains, paintings, and rare books, as well as the beautiful gardens, will supply much of interest for the remainder of the afternoon.

FRIDAY, MARCH 25

Morning

Shopping

Luncheon

At Assistance League, Hollywood, where many of the stars lunch in their makeup. A spring fashion show will be given, modeled by Los Angeles society girls. Gift shops and art exhibits are also of interest.

Afternoon

Auto trip through Hollywood, Beverly Hills, motion-picture actors' residences, Hollywood Bowl, and the beaches.

The Women's Committee suggests that a word about clothing may be appreciated. As the weather may be either warm or quite cool, medium-weight clothes for the day time and a warm coat for the evening will be in order. Sports clothes are quite universally worn in California.

A.S.M.E. At Hollywood

Only members and their wives will be admitted Wednesday evening March 23, when "a motion-picture show especially for A.S.M.E." will be put on by one of the large producers. "How Motion Pictures are Made" is the title of the evening's events, and the details when completed will look something like this: (1) The recording laboratory showing how sound is dubbed on the film; (2) a description of the Walt Disney method of making cartoons and drawings; (3) the Edward Nassour system of cartoons; (4) personally conducted tours through certain studios; (5) evening entertainment of a four-hour show indicating how pictures are made from the book to the finished product.

Inspection Trips

The following inspection trips will be unusually interesting; and for those attending from east of the Rocky Mountains they may be termed quite unusual.

C. F. Braun & Co., manufacturers of equipment for the Petroleum Industry
Oil Fields of Los Angeles County
California Institute of Technology Laboratories
The 200-Inch Telescope now in the shops at "Cal Tech" where it is being ground
Long Beach Plant of Southern California Edison Co.
Vernon Diesel-Engine Generating Plant
Douglas Aircraft Plant at Santa Monica
Motion-Picture Studios
Kobe, Inc., at Huntington Park
Northrop Corporation at Inglewood
Mt. Wilson Observatory

Low Rate Land-Sea Holiday Combination Available

Judging from the interest of A.S.M.E. members in the arrangements with the American Express Company for a conducted tour to cover the period March 15 to April 11, which will take them to Los Angeles in time for the Spring Meeting March 23–25, many are glad of an opportunity to combine attendance at the Meeting with a land-sea travel holiday.

The entire itinerary requires only four weeks, and at a cost of less than $325, includes such fascinating places as the historic Indian Pueblo District in New Mexico, the Grand Canyon at Arizona, and after the meeting at Los Angeles, a delightful sea journey on the *S.S. Virginia* of the Panama Pacific Line, stopping at Acapulco, Mexico, at the Panama Canal Zone, passing through the Canal, and visiting Havana.

The price includes transportation on any main-line railroad between New York and St. Louis and Chicago where the group will assemble, going on to join others at Kansas City, where that city's Section will entertain with sight seeing.

If you wish to join this congenial group, write to the Secretary's Office, or fill in the coupon provided on page 40 of the advertising section of this issue, and mail it at the earliest possible moment.

"Old Timers" Meeting

A considerable number of "Old Timers" from the East will be on hand to welcome their old friends. Prof. L. P. Breckenridge, Spencer Miller, Dean George W. Bissell, Ernest N. Wright, Joseph G. Prosser, Charles H. Repath, Charles V. Kerr, Charles L. Griffin, George L. Hoxie, John A. Serrell, Olaf Tyberg, Edward Thomas Adams, John L. Bacon, Charles Longstreth, C. G. Herbert, John G. Hackstaff, H. Dalzell Wilson, W. R. Eckart, David H. Ray, Paul F. Johnson, J. Grant Kingsbury, Philip L. Clarke, E. G. Elliott, Walter H. Adams, Carl C. Thomas, S. M. Marshall, H. K. Hathaway, C. F. Wieland, H. N. MacLaren, F. F. Mahl are but a few of the many members who joined A.S.M.E. thirty or more years ago and are enjoying California sunshine.

James B. Mayo Resigns as Secretary of A.S.M.E. Greenville Section

HAVING served as secretary of the Greenville Section, A.S.M.E., since 1923, James B. Mayo, member of the Society, resigned in the fall of 1937. He was instrumental in getting a group from Canton, N. C., Asheville, N. C., Greenville, S. C., and Clemson College to hold a preliminary meeting with the idea of organizing a local section to represent the mechanical engineers in that area. Mr. Mayo was present at the preliminary meetings and, upon the formal organization of the Greenville Section in 1923, was elected secretary. The members of the section as well as of the Society as a whole, appreciate his deep interest and zeal which made possible the many successful meetings held by the Greenville Section since its organization. It is hoped that Mr. Mayo will continue his interest and work in the Section he has served so efficiently and conscientiously these many years.

A.S.M.E. Calendar

of Coming Meetings

March 23–25, 1938
National Spring Meeting
Los Angeles, Calif.

May 4–6, 1938
Machine Shop Practice Division Meeting
Rochester, N. Y.

May 6–7, 1938
Textile Division Staple Rayon Conference
Washington, D. C.

June 20–24, 1938
Semi-Annual Meeting
St. Louis, Mo.

The Members' Page

A Forum for Frank Discussion by A.S.M.E. Members

Unification of Engineering Societies

THE MEMBERS' PAGE:

Discussion of the advisable relationship between the founder or technical societies and the National Society of Professional Engineers opened by Mr. Larkin in the August Members' Page, and discussed by Mr. Hescheles in the September issue, is, in my belief, a matter of vital interest to every member of our Society. As a life member of The American Society of Mechanical Engineers, my first loyalty is to this society. As a founder member of the National Society, I warmly endorse its purpose of obtaining public and political recognition for the legalized profession and I watch its spontaneous growth with satisfaction.

Present Coordination Not Possible

I have tried to see some happy and practical way of close coordination between the two groups, but it seems to me, at present at least, perhaps better that each should try to continue its own special functions without overlapping but with a spirit of entire friendliness and cooperation.

It seems to me that, at this time, any attempt at a unification such as Mr. Hescheles suggests would be like having a Civic Club and a half-dozen churches of different sects in a town and trying to effect a union of all the churches with the civic club into a single organization, merely because all members of the club attended the different churches. This might prove somewhat difficult because the type of organizations and their aims, managements, finances, and the like are entirely different. This is true in a way in regard to the technical societies and the professional groups.

Technical societies are distinctly societies supporting, by the members' dues, a central office or management and dues-collecting body whose policies are directed largely by a resident manager or secretary with a large staff of paid assistants. Branches and sections are subsidiary and permissive, and the individual members have practically nothing to say in the operation of the society. All questions of any importance are decided by the central governing body. Committee work and research are largely subsidized by corporations or corporation executives, as members serving on committees generally have their time and expenses paid by their employers. Members attending meetings and conventions also usually have their time and expenses paid by their employers (excepting the employers themselves) except section delegates whose costs are paid out of member dues.

I have attended committee meetings and conventions as a Local Section delegate, committee member, and as chairman many times in my 26 years' membership and continue to take a close and active interest in the technical work of the Society. I have served thus while engaged consecutively as a corporation employee and executive, a corporation head and employer, and as an engineer in independent personal-service practice. I have personally spent thousands of dollars in connection with my activities for the Society. I mention this to show that I am familiar with the subject and can speak authoritatively. I am offering no criticism. I believe that to fulfill its purpose the Society must not only have its membership income but also must be largely assisted by corporate employers.

The member benefits by having his personal technical horizon widened, while the employer has the vast benefit of the advancement of technique for commercial application, and the general public without knowing it is the ultimate beneficiary of the discoveries of research, technological development, and the advantages of standardization. The technical society thus fulfills its purpose for the good of all.

On the other hand, with the National Society of Professional Engineers you have an almost diametrically opposite type of association. It is a professional unity of all classifications of engineers conjoined together in active endeavor for the betterment of the profession. Instead of a central directing office, the national body consists of delegates sent by each state society and it is entirely dependent upon and subservient to the state bodies who contribute a proportion of the funds that they receive from the local chapters for the necessary minimum expenses of the national body. The different state societies of professional engineers are in turn dependent upon and subservient to the local chapters and every member in every chapter has an opportunity to be heard at the monthly or bimonthly meetings of his chapter.

It is a society for the benefit of the engineering profession primarily and not for the advancement of corporation interests. It takes no part in the different techniques of the many and indivisible activities of the engineer, but it demands public and political recognition for the immense work that the engineer is doing in his various technical groups as well as in the performance of his daily services.

Thus The National Society of Professional Engineers directed by the affiliated state groups fully supplements, completes, and crowns the educational, technical, and social work of the engineering schools and educational societies, the founder groups, and the engineers' clubs by placing the engineer before the public as a member of a high profession, and as a leader in affairs of state, local and national.

N.S.P.E. Objectives

In the short time that has elapsed since their organization, the affiliated professional societies have done much toward the accomplishment of the following enumerated objectives:

(1) An elevated status for the professional engineer with deserved public prestige and political recognition for the profession.

(2) Improvement in modes of engaging engineering services.

(3) Limitation of the designation "Engineer" to those rightfully entitled to use it, and prevention of the performance of engineering duties by other than qualified engineers, in either public or private work.

(4) Assistance of engineers in need.

(5) Election of engineers to public office.

(6) Promotion of participation of professional engineers in matters of national, state, and local importance and cooperation with national, state, and local governments, officers, commissions, associations, societies, clubs, or other groups for the purpose of public service to their country and its citizenry.

(7) Political inclusion of the professional engineer in planning, development, and operation of public projects and na-

(*Continued on page 186*)

A.E.C. Undertakes New Projects

Annual Meeting, Jan. 13 to 15, Covers Wide Range of Subjects

DISCUSSION of projects in various stages of development, reports of officers, operating, standing, and special committees, election of officers, a conference of secretaries of engineering societies, an All Engineers' Dinner with an attendance in excess of 500, and addresses by Congressman Jennings Randolph, of West Virginia, and James D. Mooney, vice-president General Motors Corporation, were high points of the eighteenth annual assembly of the American Engineering Council and the eighth Conference of Engineering Society Secretaries which were held at the Mayflower, Washington, D. C., Jan. 13 to 15, 1938.

The American Society of Mechanical Engineers was represented by its delegation headed by President Harvey N. Davis and consisting of W. L. Batt, Eugene W. O'Brien, A. L. Davis, alternate for R. E. Flanders, and T. S. McEwan, alternate for W. A. Hanley; also K. H. Condit, chairman, Committee on Publicity, A.E.C., and L. P. Alford, member, A.E.C. Committee on Constitution, By-Laws, and Standing Rules. Ernest Hartford, assistant secretary, A.S.M.E., acted as chairman of the Conference of Secretaries of Engineering Societies and C. E. Davies, secretary, A.S.M.E., spoke at the secretaries' luncheon on Thursday noon.

Secretaries' Conference Opens Sessions

Three sessions of the Secretaries' Conference, which opened with a word of greeting from A. A. Potter, president, A.E.C., were devoted to a discussion of subjects relating to secretarial management, the functional relationships of engineering societies, and employment and public relations. Adjourning for luncheon after the first of these sessions, the secretaries listened to an informal address by C. E. Davies on coordinating engineering-society activities, in which it was pointed out that the problem of the secretaries is one of harmonization.

Following the afternoon session an informal reception and tea was held at the home of Mr. and Mrs. Frederick M. Feiker. Receiving with the executive secretary of the Council and Mrs. Feiker were President and Mrs. A. A. Potter, President-Elect and Mrs. William McClellan, and Assistant Executive Secretary and Mrs. Lemuel V. Reese.

At the close of the Conference, W. H. Sanford, secretary, Engineers Club of Philadelphia, was elected chairman of the 1939 Conference, and a committee was appointed to draft a manual on society operation, consisting of Ernest Hartford, assistant secretary, A.S.M.E., O. L. Angevine, secretary, Rochester Engineering Society, and Kenneth F. Treschow, secretary, Engineers Society of Western Pennsylvania.

A. A. Potter Addresses Assembly

Formal sessions of the Assembly of the American Engineering Council were held Friday morning and afternoon and Saturday morning, preceded on Thursday by meetings of the executive and other committees. In his address of welcome, President Potter spoke of the services and accomplishments of the Council and urged all representatives to keep the members and officers of the constituent societies of which the Council is composed fully and reliably informed on all matters pertaining to the work of the Council. Dean Potter said in part:

Statements are made that the American Engineering Council is not fully representative of the engineering profession. The following figures are, accordingly, significant:

Out of 144,065 American lawyers, as given in Boyd's Directory, 28,400 (World Almanac), or less than 20 per cent, are members of the American Bar Association.

Of the 140,398 medical practitioners in this country (Boyd's Directory), 102,715, or 72 per cent, are affiliated with the American Medical Association.

The U. S. Census gives the number of engineers and surveyors as 212,000. Of these not more than 176,000, as a liberal estimate, are eligible for membership in engineering societies. The number of engineers (unduplicated) represented by the American Engineering Council, through its 53 member societies (7 national, 17 state, and 29 local) is approximately 71,875, or about 41 per cent of the engineers of this country who are eligible for membership in our major societies.

A.E.C. Representative of Profession

These figures indicate that the American Engineering Council is much more representative of the engineering profession than is the American Bar Association of the legal profession. However, in order that it may be in a position to serve the engineering profession most effectively it should be as representative of its profession as the American Medical Association; that is, it should have affiliated with it more organizations which may properly support its objectives. This country has numerous engineering societies for advancing the profession, for improving technologies and practices, and for promoting forums of discussion of matters pertaining to engineering. The American Engineering Council, however, was created as the only functional instrumentality intended to aid the engineering profession in presenting a united front in matters of interest to the public and to our government. To be fully representative of our profession, A.E.C. should have more of the major engineering groups affiliated with it.

It is obligatory for those present at this Assembly to carry to the membership of their respective societies the material which A.E.C. makes available through its news services and at these meetings. It is a responsibility of the representatives of societies to study the reports issued by the American Engineering Council and to make an earnest effort to bring the contents thereof to the attention of their respective constituents. The attitude of the average engineer about the American Engineering Council and his lack of familiarity with its objectives and accomplishments, lead me to feel that in the past, representatives of member societies have not fully informed themselves about the problems, policies, and functions of their jointly sponsored agency, and have failed to keep the governing bodies of their societies fully acquainted with the many services being performed for them.

Influence Depends on United Front

I am in full accord with the views of some leaders of our profession who feel that our influence depends upon our ability to present a united front, to exert a strong group influence on the course of government as it affects engineering. In my remarks before this Assembly a year ago, I stated that "it is most essential for the American Engineering Council to make engineering opinion and engineering thinking on public matters known to those who are directing our government. . . . Engineers should show their competency and integrity to make the public at large more conscious of engineering contributions." Recent years have witnessed major social, economic, and political changes which are greatly affecting the engineer and his work. Some of the plans now under way in an effort to mold our future, to remedy present ills, may result in retarding technological advance, which is greatly influenced by opportunities for individual initiative and freedom from directive laws.

This A.E.C. Assembly at this meeting has an opportunity to show its leadership for our profession by publicizing engineering group opinion and by definite pronouncements about

J. D. MOONEY

A. S. TUTTLE

L. J. FLETCHER

public matters which affect engineers and engineering. Representing as it does, the most influential and largest group of the engineering profession, the American Engineering Council, as an unbiased nonpartisan organization of 53 national, state, and local engineering societies, is in a position to exert a most beneficial, group influence upon public matters of joint interest to all engineers.

New A.C.C. Projects Suggested

Discussions and actions of the Council during its sessions on Friday centered on new projects which were referred to the executive committee, progress reports of special and standing committees, and adoption of a resolution favoring a Department of Public Works to include all such activities of the government but to exclude the civilian work of the Corps of Engineers.

Reporting on the survey of the engineering profession carried out by the Bureau of Labor Statistics at the suggestion and with the cooperation of the American Engineering Council, progress reports on which have appeared from time to time in MECHANICAL ENGINEERING, George T. Seabury, secretary, A.S.C.E., said that, in the opinion of Isador Lubin, of the Bureau, the study should be supplemented so that further information on earnings and employment status of engineers during the depression might be extended to include conditions as of Dec. 31, 1936, and 1937. By vote of the assembly the Executive Committee was authorized to consider this supplemental study and also the ways and means of undertaking it.

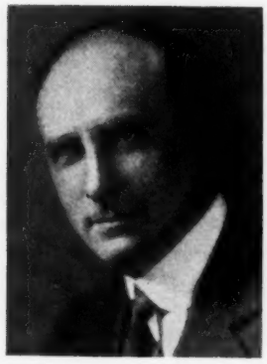
On behalf of the Council of the A.S.M.E. Harvey N. Davis presented a request, referred by the Assembly to the Executive Committee, that the A.E.C. undertake a study of wage scales for engineers in sub-professional levels. To the Executive Committee was also referred the suggestion that the Council undertake a fact-finding study of the unionization movement as it affects engineers.

Another project brought to the Council by Dr. Davis on behalf of the A.S.M.E. delegation, and referred by the Assembly to the Executive Committee, was a request that a committee be set up for cooperation with the Army and Navy on all matters relating to the national defense where engineering skill and experience are needed, particularly in industrial planning of production for national defense. An immediate objective of such a committee would be the preparation of a classified list of 3000 leading administrators and designers.

Scientific-Research Legislation

Reporting for the special committee on scientific-research legislation, Russell S. McBride, chairman, outlined four principles relating to (1) the purpose of research activity, (2) the necessity for federal aid, (3) the necessity for aid to educational institutions, and (4) noninterference with private enterprise, on which the committee members were in substantial agreement. The portion of the report relating to these principles was received as a progress report for the guidance of the A.E.C. staff and the Executive Committee, and the special committee was requested to continue its studies with a view to a further report next year.

WM. MCCLELLAN



A. A. POTTER

F. M. FEIKER

At a luncheon following the morning session, Congressman Jennings Randolph, who has taken an active leadership in scientific-research discussions in the Congress, developed his views on the subject of technology, capital outlets, and employment. Can engineers, he asked, provide needed capital outlets, create new industries for the employment of millions of unemployed men, and continue to keep these opportunities for investment opening up constantly?

National Planning

In reporting for the Committee on Conservation and Utilization of National Resources, L. J. Fletcher, chairman, called attention to the difference between fact-finding, or surveying, and planning. "The next step after national economic planning," he said, "is plan enforcement. Plan enforcement and free competition cannot exist together—it is one or the other.... If the privilege of free competition is curtailed, through the activities of a central planning board, even though its members be prompted by the highest of ideals, one of the most valuable possessions of the people of this country will be destroyed."

All Engineers' Dinner

With more than 500 engineers in attendance the All Engineers' Dinner on Friday evening afforded an opportunity for the Assembly and members of the profession residing in and around Washington to come together for a few hours of good fellowship. Following the dinner, at which President Potter presided, officers of the engineering societies and the secretaries in attendance were introduced. President-Elect William McClellan spoke with feeling on the importance of the work of the Council and dedicated himself to its immediate tasks.

Arthur S. Tuttle, past-president, A.S.C.E., acted as toastmaster and introduced the speaker, James D. Mooney, vice-president, General Motors Corporation, whose subject was "Some Observations on Economics, Politics, and Government." Basing his opinion on his personal observations of the governments in many parts of the world, Mr. Mooney said that the defense we need in the United States against too much governmental control is to be found in the traditional two-party system, which has given us a reasonably good compromise between a strong government and individual freedom.

Wm. McClellan Elected President

At the session on Saturday the tellers announced the election of Wm. McClellan, president Potomac Electric Power Co., Washington, D. C., member A.S.M.E., as president of the A.E.C. for a two-year term. Other officers elected were: vice-presidents, Ralph E. Flanders, past-president, A.S.M.E., and Alonzo J. Hammond, past-president A.S.C.E.; and treasurer, L. J. Fletcher, Caterpillar Tractor Company. Frederick M. Feiker was re-elected executive secretary. Vice-presidents remaining in office are Carroll O. Bickelhaupt, of New York, and John S. Dodds, of Ames, Iowa.

Many Committees Report

Reports were received from many committees. Revision of the constitution was reported as being in progress. Favorable action was reported on applications for membership of five engineering societies. Negotiations are in progress in the cases of three others, bringing the total membership to 53, largest in the Council's history. Negotiations are also in progress in respect to 8 national, 2 state, and 7 local societies.

The report of the treasurer showed a surplus for the year 1937 of $2,930.85; and the budget adopted for 1938 indicated an expected total income in excess of expenditures of slightly over $1000.

Mr. Feiker's report as executive secretary was presented and accepted. Much discussion centered around the report of the Committee on Publicity, with expressions of opinion as to the importance and value of keeping the Councils' constituent bodies and their members fully informed on activities. Mr. McClellan announced that the Executive Committee would give extended study during the year to ways and means of providing more effective publicity.

Resolutions offered at the close of the session related to expressions of thanks and appreciation to groups and individuals, and to the Councils' position with respect to mapping and publicity.

"Mechanical Engineering" Can Use Good Camera Shots by Members

THE COMMITTEE for the Second Annual Photographic Exhibit, which proved one of the most popular features of the 1937 Annual Meeting, thanks all who contributed pictures for the exhibit.

To all A.S.M.E. camera enthusiasts, the Photographic Group suggests, as a means of applying their art and technique in a manner not without profit and appreciation, that they submit copy for cover, frontispiece, and other illustrations for MECHANICAL ENGINEERING. Objects photographed should be of a technical nature, of interest to mechanical engineers, and mechanically correct.

All photographs should be sharply defined, have contrasts of bright light and shade, and of such size and proportion as will fit them for reproduction, $8\frac{1}{2} \times 11$ in. preferably. Prints submitted should be on glossy paper, with or without mounts. A brief written description of the subject matter used is desirable.

Extreme care should be exercised to avoid the appearance, in the pictures, of much unnecessary background, and for cover illustrations the center of interest should be so located as to be well clear of the magazine title. All photographs should be submitted to Publications Department, A.S.M.E., 29 West 39th St., New York, N. Y., and whether used or not, will be returned, if requested.

Applied Mechanics Division Has Interesting Program at Annual Meeting

INTEREST in the four sessions held by the Applied Mechanics Division during the Annual Meeting in December, 1937, was so great that the accommodations provided, especially for the joint session with the Power Division on high temperature joints, were inadequate. Papers presented at the sessions covered not only the theories and formulas of mechanics, but also investigations and solutions of acute industrial problems. At the session on vibration, most of the papers were contributed by A.S.M.E. Junior members.

At the executive meeting of the Division held on Dec. 7, 1937, it was agreed that no national meeting of the Division be held during 1938, but that all efforts be along the lines of cooperating with the American committee organizing the Fifth International Congress of Applied Mechanics, to be held in Cambridge, Massachusetts, September, 1938.

The usual dinner of the Division was held on the evening of Dec. 7, 1937, C. R. Soderberg, chairman of the Division, acting as toastmaster. Dr. J. C. Hunsaker outlined the plans already under way for the congress. Professors S. Timoshenko and G. B. Karelitz discussed their recent European trips. A report on the *Journal of Applied Mechanics* was presented by Prof. J. M. Lessells.

Many Interesting Meetings Conducted by Local Sections

President Davis Visits Twelve Local Sections During January

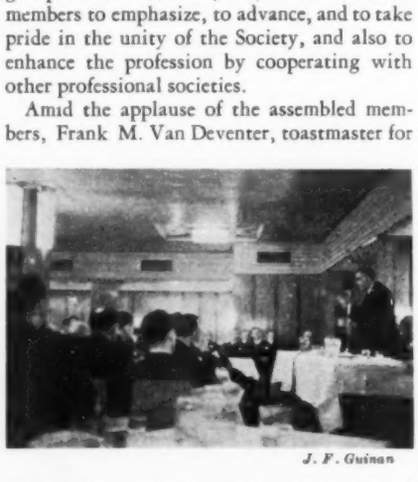
INCREASED interest and greater cooperation of members are making possible bigger and better local-section meetings. Reports received from all over the country, and even Canada, tell of the many and varied programs arranged by A.S.M.E. members, of meetings at which visitors greatly outnumber members, and of several sessions sponsored jointly with other professional societies. Therefore, the following notes on some of the meetings held during the last month or so, have been prepared.

Dr. Davis in Metro Section Talk Stresses Society Unity

Stressing the need and importance of unity of purpose and aims of members for the benefit of The American Society of Mechanical Engineers and the profession, Dr. Harvey N. Davis, newly installed president, inaugurated the first of his series of visits to local sections and student branches with an informal talk to 350 members of the Society gathered at a Metropolitan Section dinner on Jan. 11, 1938, in New York City. Dr. Davis, speaking for himself and the Society, said that all members should feel free at any time to make suggestions and constructive criticisms to Council, because it is only in this way that Council can determine the wants, needs, and interests of the membership.

The Society was founded back in 1880, and since then, has grown until today it has 16 professional divisions, one professional group, 71 local sections, and 116 student branches. Four national meetings are now being held to serve the membership who cannot come to New York for the Annual Meeting. This shows that the Society is a national organization which is advancing the profession of mechanical engineering as a whole instead of furthering the interests of a few individuals or groups. In conclusion, Dr. Davis asked all members to emphasize, to advance, and to take pride in the unity of the Society, and also to enhance the profession by cooperating with other professional societies.

Amid the applause of the assembled members, Frank M. Van Deventer, toastmaster for the occasion, thanked Dr. Davis for his fine talk and expressed the desire of having him as a guest at future affairs of the section. Preceding Dr. Davis' address, Mr. Van Deventer introduced A. L. Davis, a guest from the Waterbury Section, and members of Council, section executive committee, and headquarters staff who were present. Following the introductions, short reports were given by representatives of the various divisions and groups in the section on their work and future programs. These representatives were Adolph Ehbrecht, G. J. Nicastro, H. A. Cox, Walter W. Lawrence, Ed S. Smith, Jr., G. B. Karelitz, C. G. Humphreys, T. M. Wickenden, E. J. Devlin, P. T. Onderdonk, H. W. Taylor, E. E. Clark, C. W. Obert, Sr., and V. Brandt.



J. F. Guinan

PRESIDENT DAVIS TALKS TO MEMBERS OF METROPOLITAN SECTION ON EVENING OF JAN. 11

After attending the annual meeting of the American Engineering Council in Washington, D. C., Jan. 13 to 15, Dr. Davis left on a visit to other local sections, which included Washington, D. C., Virginia, West Virginia, Columbus, Cincinnati, Dayton, Central Indiana, St. Joseph Valley, Milwaukee, Peoria, and Chicago. This trip was in progress at the time of going to press. On the way back to New York, Dr. Davis is expected to stop off at Detroit to address the annual meeting of high-school students of the city arranged by the Engineering Society of Detroit.

Atlanta Section

The importance of fuel engineering was discussed by J. E. Tobey, member, A.S.M.E., and chief engineer, Appalachian Coals, Inc., at the December meeting.

Boston Section

"Fuels for Today and Tomorrow" was the subject of the paper presented by Dr. A. C. Fieldner, chief of the Technological Branch, Bureau of Mines, and past-president of the A.S.T.M., at a meeting following a dinner held on Jan. 10, 1938.

Bridgeport Section

Members and guests had the privilege of listening to a very interesting talk on safety and other measures in the merchant marine given by Prof. Herbert L. Seward of Yale University, Jan. 12, 1938.

Central Indiana Section

Joining with the local section of the A.I.E.E. and the Purdue University student branches of the A.S.M.E. and A.I.E.E., the Central Indiana Section held a dinner in Lafayette followed by a meeting which was attended by 200 members and guests. Wm. H. Harrison, president A.I.E.E., spoke on the interlocking of the work of mechanical and electrical engineers. Following, Claude M. Hathaway, General Electric Co., spoke on "Mechanical Measurements by Electricity," illustrating his talk with examples of uses in industry. After showing the importance of the mechanical engineer in the

electrical industry, Mr. Hathaway stated that 30 per cent of the engineers of his company are mechanical engineers. The section was well-satisfied with this meeting; and is already making plans for similar meetings in 1938.

Detroit Section

Continuing its active support of student activities, the section at its Dec. 14, 1937, meeting had two papers presented by student members of the University of Detroit. E. W. Connolly showed how labor unions interfere with the training of engineering students in cooperative schools through antagonism, rules prohibiting transfer of students among departments, and seniority rules. The second paper by D. J. LaBelle discussed the testing of wood windows for the Detroit Federal Housing Project to determine whether their infiltration characteristics conform with government specifications. Following these two interesting papers, Prof. F. J. Linsenmeyer gave an informal report of his investigation of the properties of natural gas as supplied to consumers in Detroit.

Florida Section

A two-day joint meeting was held by the Florida Section in conjunction with the local section of the A.I.E.E. at the Miami-Biltmore Hotel in Coral Gables, Dec. 27 and 28, 1938. Prof. J. H. Clouse opened the A.S.M.E. session with a few introductory remarks and then introduced Paul R. Vopp, Babcock & Wilcox Company, who discussed steam-boiler units for central stations. Following this, P. K. Blackwell, Florida Power & Light Company, described methods of handling buildings and property for hurricane protection. The concluding paper of the session was presented by J. P. Warren, member, A.S.M.E., in which he outlined a method of removing slimy growth accumulations from water contact surfaces.

Erie Section

The intricacies of lighting were discussed by K. B. Eachron, research engineer of the General Electric Co., in a paper presented at a meeting held in the Pennsylvania Telephone Auditorium, Jan. 18, 1938.

Ithaca Section

With 25 members and 30 guests, most of them members of the Southern Tier Technical Society, Ithaca Section held a very interesting meeting at the Green Lantern Inn in Oswego, N. Y., Dec. 17, 1937. Prof. S. S. Garrett of Cornell University discussed the question, "Can We Have Prosperity?" Periods of depression and prosperity were traced from 1800 to the present. Factors entering into the causes for the recent progress toward recovery and the more recent recession were presented. Effects of present labor wage rates on future trends were predicted.

Kansas City Section

Seventy members of the A.S.M.E., A.S.H.V.E., and the Operative Millers Association attended a joint meeting on Dec. 11, 1937, at which air conditioning in flour mills was discussed. Dr. C. O. Swanson of Kansas State College discussed the research work in the subject conducted at the college and Edgar Miller, technical editor of the *Northwestern Miller*, described the problems encountered in actual mill installations.

Mid-Continent Section

The last monthly luncheon meeting of the section for 1937 was held in Tulsa on December 20, the problem discussed was "Well Acidizing." Guests at the affair were the members of the Engineers Club of Tulsa. In turn, the members of the A.S.M.E. are invited to attend the engineering luncheons held by the club the other weeks of each month.

New Britain Section

At a meeting held on Dec. 15, 1937, new developments in foundry equipment was the topic of the evening. R. T. Lincoln presented the molding phase, illustrating his talk with slides showing molding equipment in use today, and F. W. Pedrotty described the cleaning phase, including motion pictures of a new-type cleaning machine.

Norwich Section

W. W. Forman, general engineer, Connecticut L. & P. Co., at a meeting on Dec. 20, 1937, used slides to describe the growth of his company's system in the state. The remainder of his talk was devoted to a description of the principal engineering features of the new turbo-generator unit installed at Montville.

Ontario Section

At a joint meeting held in Toronto with the local section of the A.S.H.V.E., on Jan. 10, 1938, Prof. E. A. Allcut, member, A.S.M.E., and professor of mechanical engineering, University of Toronto, discussed heat-insulating materials and their properties.

Peoria Section

With 20 members and 110 visitors present, the December meeting was addressed by Alex D. Bailey, Fellow, A.S.M.E., who stated that chemists and metallurgists have not yet created materials which can withstand the high temperatures and pressures necessary in modern plants. Citing examples and statistics, Mr. Bailey pointed out the complexities of present-day power plants.

Providence Section

At its December meeting, the section had the pleasure of hearing Prof. Charles Smiley of Brown University give an illustrated talk on his 8000-mile round trip to Peru, S. A., to observe the 202-second total eclipse of the sun last June. He described the construction of a Schmidt astronomical camera, using F-1 lens, used to photograph the eclipse.

San Francisco Section

The interest in the December meeting of the section was well-attested by the attendance of 95 members and 25 guests. Presenting the history, plans, power development, and reclamation features of the California Central Valleys Project, Edward Hyatt, engineer of the State of California, and Lester S. Ready, member of the Federal Power Commission, showed how this important project will affect the welfare and development of every industry and citizen in the great central area. Extended discussion and reply by the speakers followed some interesting remarks by General E. H. Schulze, U. S. Army, concerning navigation, irrigation, potable water, and construction. At the business meeting preceding the session, W. Harry Archer was appointed to represent the section on the San Francisco Building Industries Conference Board and G. L. Sullivan, chairman of the section, was approved as chairman of a special committee from the San Francisco engineering Council to cooperate with the Civil Service Board of the City in a study of the salaries, job specifications, etc., of civil-service positions.

J. P. Guinan

THE "BOYS" PLAY HOCKEY AT THE METRO SECTION MEETING, JAN. 11

St. Louis Section

On Dec. 17, 1937, the section held a dinner meeting followed by a dance. Prof. Lloyd R. Koenig exhibited colored slides of pictures taken on a recent horseback trip through the Rio Grande and Gila Rivers districts in New Mexico.

West Virginia Section

Discussing modern pulverized-fuel equipment at a meeting of the section held on Dec. 20, 1937, at Charleston, R. L. Lindemuth, Combustion Engineering Co., illustrated his talk with slides which explained the working of the ball mill and impact mill in pulverizing coal. Then he described various types of nozzles and the firing of the coal. Illustrations of typical installations were shown and discussed.

Western Washington Section

A very interesting program was presented at the section's Seattle dinner meeting held in December by having all papers given by members. There were 35 members and 8 ladies present at this very successful affair. Prof. E. O. Eastwood described his recent trip to New York as a delegate of the Society to the Annual Meeting. John K. Morris read an interesting paper on gears and speed reducers. C. L. Burnett gave a very interesting talk about the Tennessee Valley Authority, having worked on that project in a consulting capacity during the early years of its existence. He told of the economic condition of the people in the territory served and how difficult it is to raise the standard of living of such people, especially when they are satisfied with things as they were originally.

Junior Group Activities

Junior Questions Bring Interesting Answers

APPROXIMATELY 1000 questionnaires were sent to juniors in the Metropolitan Section of the A.S.M.E., by the Junior Group of that Section, and about 200 replies were received. Some high lights of the replies were: (1) 82 per cent had been Student Branch members; (2) nearly all either want to secure professional engineers' licenses or already hold them; (3) the first four days of the week are favored for meetings; (4) 40 per cent indicated a willingness to serve on committees; (5) 71 topics were suggested for meetings, but labor relations leads in interest; (6) 60 per cent are in favor of dining with other juniors before the meeting; (7) 6:00 p. m. is the preferred dinner hour, and 7:30 p. m. is first choice for meetings.

Metro Juniors Inspect Telegraph Capital

THE 24-STORY Western Union Telegraph Company building, 60 Hudson Street, New York City, known as the Telegraph Capital of the World, was inspected by the Metropolitan Junior Group as the feature of their January program.

Under the direction of trained guides familiar with the general and technical features of the building, the Juniors saw the power-supply equipment, with emergency features such as a reserve turbine unit, and coal- and oil-fired boilers. An interesting side light was the incinerator, where a ton of "old business" is burned daily. Much interest was displayed in the various testing and development laboratories where chemical, mechanical, metallurgical and, electrical research is carried on with a view to constant improvement of service. The climax of the trip was a glimpse of the telegraph offices where thousands of messages are sent and received hourly over simplex and multiplex machines. Within the building is a network of systems for message handling including 50,000 feet of pneumatic tubing. Conveyor belts and messengers on roller skates both serve to speed internal communication. Over 300,000 feet of pneumatic tube connect this building with 42 branches within a radius of two and one-half miles.

Active Season Reviewed by Waterbury Juniors

PAPERS by both junior and senior members of the Society have featured the active fall and winter season of the Waterbury Junior Group. In October, E. W. Soderberg spoke on "Plastics;" and H. W. Townsley, another Junior, discussed "Unusual Uses of Rubber." "The Whys and Wherefores of Standardization" were capably considered by Frank O. Hoagland, of Pratt and Whitney, at the November meeting; and in December, A. L. Davis spoke on "Modern Trends in the Alloying of Steels."

A joint meeting with the senior members was held in January, conducted by the Junior Group. "The Labor Situation" was the general topic, with Allen Curtiss taking the side of business and Frank Rising the side of labor.

Kansas City Junior Group Appoints New Officers

TWO TALKS by Juniors and one by a senior member featured the December meeting of the Kansas City Junior Group.

The application of the seismograph to the oil industry was discussed by Robert Oliver, a Junior, who outlined the manner in which this instrument is used as a fast method of determining the possible location of oil. Glen Brauninger, speaking on the peace situation, indicated that a concerted effort was being made, by a Peace Action Committee of citizens, to keep the United States out of war. The committee has suggested an effective scheme for this purpose and those interested were asked to join the movement.

"The Astronomical Telescope" was the subject of a talk by Mr. Brown of the Kansas City Section, in which the methods used by amateurs in building astronomical telescopes were explained. A telescope that Mr. Brown had made was shown as an example of what the amateur could construct in the home workshop.

The Kansas City Group has a new chairman, Raymond Hahn. Mr. Hahn, former secretary, was appointed to fill the unexpired term of Mr. Hoover, who has been transferred from the city. Robert Glore is the new secretary.

Cleveland Juniors Hear Talk on Welding Design

THE CLEVELAND Junior Group acted as hosts to a prominent consulting engineer at their December dinner meeting, held on the campus of the Case School of Applied Science. In return, they were treated to an instructive and up-to-the-minute talk on "Modern Welding Design."

The speaker, E. W. P. Smith, consulting engineer for the Lincoln Electric Company, showed the economies which follow the adoption of arc welding as a fabricating process and pointed out the surprising number of products to which welding may be applied. He stressed the importance of proper design of the product as being essential to gaining all the advantages inherent in the use of welding. To demonstrate the effect of the type of joint used to join two plates, he prepared rubber models ruled off in rectangular coordinates. When tension was applied, stress distribution could be seen by the changes in position of the lines, a graphic presentation of a complex problem.

Toronto Juniors Arrange Section Dinner Meeting

THE ONTARIO Section met under an entirely new arrangement when the Junior Group organized a novel dinner meeting at the Toronto Flying Club. Every detail of this December gathering was handled by the Juniors, even to the extent of providing transportation for those members not driving cars.

Forty-five engineers attended the dinner and thirty others came later for the meeting, which filled the club to capacity. After a toast to the King, the meeting was turned over to the Junior Chairman, H. G. Hill, who gave a brief outline of the Group's activities, and introduced the speaker, Professor T. R. Loudon, of the University of Toronto, a recognized authority on aeronautics and a Director of the Flying Club.

The subject, "Commercial Air Service," proved intensely interesting, particularly as it included discussion of the new Trans-Canada Air Service. Professor Loudon added color to his address by showing a talking movie of regular transport and passenger service from Croydon Airport, England.

The fact that several members drove forty miles from Hamilton and other points, indicates the success of the meeting.

Metro Seminar Groups Active in January

THE AERONAUTICS Seminar, National Defense Seminar, and the Air-Conditioning Seminar of the Metropolitan Junior Group, held interesting meetings during January.

"Gliding in the Metropolitan Area" was described by L. E. Mehmel, Foster Wheeler Corporation, at the January 19 meeting of the Aeronautics Seminar. Mr. Mehmel is an active gliding enthusiast and is familiar with the problems of gliding over the city and its environs. He illustrated his talk with motion pictures.

The Aeronautics Seminar is one of several groups within the Junior Group which were instituted to bring together men with similar interests. Under the direction of S. Shoor, this seminar was reorganized early last Fall, and has since attracted an enthusiastic group of Juniors interested in the problems of flight.

The National Defense Seminar was particularly fortunate in having Colonel Crosby Field, U. S. Army Ordnance Corps., industrialist, and chairman of the Standing Committee on Professional Divisions of the A.S.M.E., as the principal speaker at its meeting of January 6. Colonel Crosby's discussion of "Procurement Planning" was arranged shortly after his return from the Industrial War College in Washington, so that the members of the seminar might learn of the preparations that must be made if a nation's defense mechanism is to be ready for an emergency.

Carlos de Zafra, professor of mechanical engineering at New York University, and a member of the U. S. Army Ordnance Reserve, will be the speaker at the February meeting of the Seminar.

C. N. O'Day, sales engineer, Preferred Utilities Company, Inc., spoke to the members of the Air-Conditioning Seminar on "Practical Applications of Electric Controls to Air Conditioning and the Year-Round Importance of Proper Air Distribution," at the January 18 meeting. The long and varied experience of the speaker made the meeting highly instructive, and the general discussion that followed was additional evidence of the interest in this field.

A premeeting dinner was held at Leeds Restaurant. The arrangements for the meeting were in charge of S. Shoor, and the chairman was Sidney Davidson.

With the Student Branches

Student Members to Receive Prizes Worth More Than $1500

Old Guard Members, Funds, Society, and Local Sections are Donors

THE KEEN interest shown by The American Society of Mechanical Engineers and its members in the excellent work being done by the student members in the Student Branches is evidenced best by the many cash and other prizes awarded annually to student members. At the 1937 Annual Meeting, the value of these prizes was increased to more than $1500 through the generosity of the Old Guard, in other words, those members who have been affiliated with the Society 35 or more years.

A list of the various awards available to student members is hereby presented together with a brief description of the basis of each award, the method of selecting the winner, and the nature and value of the prize. It should be noted that Junior Membership Prizes, which are paid-up dues for one year, are awarded on condition that the election of the students to the next higher grade receives favorable action by the Admissions Committee.

Old Guard Prizes

During the fall of 1937, those members of the Society who had been members 35 years or more, voluntarily collected a fund to be administered in behalf of student members by a committee of the Old Guard. The committee has decided on the following procedure:

1 To place $100 in the hands of the Committee on Relations with Colleges to provide ten special Old Guard Prizes of $10, each, to be administered with the other prize money set up by the Society for each of the ten Student Meetings held each spring throughout the country.

2 The Old Guard Committee will pay the expenses to New York for the Annual Meeting of the recipients of the Charles T. Main Award and the Student Awards.

3 The Student chairman or an elected representative of each Student Branch represented at the Annual Meeting is to be guest of the Old Guard at the formal dinner of the Society during the Annual Meeting.

Charles T. Main Award

A cash award of $150, established in 1919, from a fund created by Charles T. Main, past-president of the Society, is awarded annually together with an engraved certificate, to a student member of the Society, for the best paper submitted to the Board of Honors and Awards on a subject selected by the Board and approved by Council. The subject for 1938 is "Economic Limitations in Engineering Design, with Concrete Examples," and the paper, containing not less than 2000 words, must be submitted on, or before, June 30, 1938. Winner of the award for 1937 was Allan P. Stern, student member of Case.

Student Awards From Hess Fund

Two annual cash awards of $25, each established in 1914, from a fund created by Henry Hess, past vice-president of the Society, are given with engraved certificates, signed by the President and Secretary of the Society, for the best papers on any engineering subject or investigation, prepared by members of any student branch and submitted on or before June 30 of each year, to the Board of Awards and Honors. One award is presented to a graduate student and the other to an undergraduate student. Gino J. Marinelli, student member of the Rensselaer Poly Branch, won the 1937 undergraduate award for a paper dealing with the subject "Investigation of the Towing Resistance of a Model Submarine Hull."

Prizes for Papers at Student Meetings

Each Spring, groups of student branches in cooperation with the Committee on Relations with Colleges, conduct ten regional Student Meetings at which student members present technical papers. At each meeting, cash prizes amounting to $85, exclusive of the $10 presented by the Old Guard, are awarded, according to a distribution plan decided upon by the student members themselves, to the students presenting the best papers as selected by a board of judges. The last few years, distribution of the awards was made on a basis of three prizes of $50, $25, and $10 each, or four prizes of $35, $25, $15, and $10 each. In addition to the above cash prizes, S.K.F. Industries, Inc., of which William L. Batt, past-president of the Society, is president, has presented each year a slide rule to the author of the next best paper, which may be the fourth or fifth best, depending upon the cash distribution plan. The total value of the cash prizes and the slide rules awarded each year, exclusive of the Old Guard prizes, amounts to about $900.

GINO J. MARINELLI AND HIS SUBMARINE-TESTING EQUIPMENT

Awards by Local Sections

The following compilation of prizes given by some local sections has been prepared from reports sent in last year by student branches. Consequently, the details, as presented, may not be entirely complete or accurate. Additional information is welcome for later publication in MECHANICAL ENGINEERING.

Anthracite-Lehigh Section—Student Branches: Lafayette College and Lehigh University. Prizes: To each branch a Junior membership (value $10) to be awarded to student member doing most for branch or standing highest in class.

Boston Section—Student Branch: Northeastern. Prize: Carfare paid to meeting.

Chicago Section—Student Branches: Armour Institute, Northwestern University, and Lewis Institute. Prizes: To each student branch a Junior membership (value $10). Basis of award not stated.

Detroit Section—Student Branches: Michigan University, University of Detroit, and Michigan State College. Prizes: Junior memberships (value of each, $10). Basis of award not stated.

Florida Section—Student Branch: University of Florida. Prizes: $10 each semester for best papers, distribution on basis of $5, $3, and $2 each. In addition, the section gives an hono-

rarium of $5 to each student who presents a paper at a local-section meeting.

Inland Empire Section—Student Branches: University of Idaho and Washington State College. Prizes: To each branch a Junior membership (value $10) for best paper presented during year; and a cash prize (amount not stated) for the second best paper.

Knoxville Section—Student Branch University of Tennessee. Prize: $10 for best paper presented by student member.

Los Angeles Section—Student Branches: California Institute of Technology and University of Southern California. Prizes: $25 in prizes for best papers presented by student members at a joint meeting.

Mid-Continent Section—Student Branches: University of Oklahoma, University of Arkansas, and Oklahoma A.& M. College. Prizes: To each a slide rule (value $5). Basis of award not stated.

Minnesota Section—Student Branch: University of Minnesota. Prizes: Three prizes, $25 and handbook (value $8); $15 and handbook (value $8); and $10 and handbook (value $8), for best student papers.

Nebraska Section—Student Branch: University of Nebraska. Prize: Junior membership (value $10) to student member based on his A.S.M.E. activity, his scholarship, and his presentation of papers at branch meetings.

New Orleans Section—Student Branches: Tulane University and Louisiana State University. Prizes: None. However, a donation is made to each branch's fund for transportation of student members to the regional Student Meeting.

Oregon Section—Student Branch: Oregon State College. Prizes: Three prizes, $15, $10, and $5, for best papers presented at joint meeting.

St. Louis Section—Student Branches: University of Missouri, Washington University, and Missouri School of Mines. Prizes: One Junior membership (value $10) to each student branch. Basis of awards not stated.

South Texas Section—Student Branches: Rice Institute, Texas A. & M. College, and University of Texas. Prizes: Two prizes, $15 and $10, for best papers presented at a joint meeting.

Tri-Cities Section—Student Branches: Iowa State College and University of Iowa. Prizes: To each branch a Junior membership (value $10) for the best paper and $5 in cash for the next best one.

Utah Section—Student Branch: University of Utah. Prize: Junior membership (value $10) for best undergraduate thesis by student member.

Virginia Section—Student Branch: Virginia Polytechnic Institute. Prize: Junior membership (value $10). Basis of award not stated.

Washington, D. C., Section—Student Branches: George Washington University and Catholic University. Prize: To each branch a Junior membership (value $10). Basis of award not stated.

Branch News

Hanley Speech Contest at Purdue

PURDUE BRANCH reports a plan to get students interested in the annual Hanley Speech Contest which was originated by William A. Hanley, general manager of Eli Lilly & Co. and chairman of the A.S.M.E. Committee on Relations With Colleges, when he realized that many engineers did not have the proper training in public speaking. The subject of the talks must be of both an engineering and an economic nature. Cash awards are given to the winners who are selected by a board of judges.

100 Per Cent Attendance at Brown

At the first meeting held in 1938 by the BROWN BRANCH, the entire membership turned out to view a sound-motion picture of the manufacturing, fabrication, and uses of stainless steel. An open discussion led by Mr. Thayer, Republic Steel Corporation, followed the showing of the film.

CALIFORNIA TECH BRANCH listened to an interesting paper on the role which nickel plays in the development of modern cast iron, given by Albert G. Zima, International Nickel Co., Inc.

Case Holds Treasure Hunt

The senior members of the CASE BRANCH made the annual test of the school's boilers and power-generating equipment, spending 30 hours on the job. Then the 75 members of the branch enjoyed themselves at their annual treasure hunt and banquet. Sample products from various companies and paperweights, made in the school shop, were given out. The entertainment consisted of humorous papers which were presented by members of the faculty and a treasure hunt in the mechanical building.

COLORADO BRANCH members had an opportunity to welcome C. M. Hathaway, a graduate of the school and now connected with the General Electric Co., who gave a fine educational lecture on mechanical measurements by electricity.

Cornell Has 250 at Meeting

Fifty-two members of CORNELL BRANCH acted as hosts to 198 visitors of the A.S.C.E. and A.I.E.E. student branches at a meeting which featured a paper by Samuel L. Hoyt, metallurgist, A. O. Smith Co., entitled, "It's all in a Metallurgist's Life." He described his work, and its relation to the engineering profession. A new alloy developed by Mr. Hoyt was described with the aid of slides.

Detroit Branch Meets With Section

Congratulations to DETROIT BRANCH for having such fine members as Edward Connolly, chairman of the Branch, and Donald La Belle. Each of these students presented a paper at a regular meeting of the Detroit Section of the A.S.M.E. which was comparable in subject and content to those presented by senior members of the Society. Full details will be found in this issue under the local sections' news. At a meeting of the branch, Maxwell C. Maxwell gave a lecture on the romance and mechanics of locks.

Duke to Celebrate Centennial

DUKE BRANCH is already making plans for the centennial anniversary celebration of the founding of the school which will begin in October of 1938 and culminate with a formal program on April 21, 22, and 23, 1939.

A successful meeting, attended by 130 members and guests, was arranged for the IOWA STATE BRANCH by a student member W. R. Madson. The program consisted of a group of motion pictures obtained from various industrial concerns.

KANSAS BRANCH heard a talk by Walter Bohnstengel, Sante Fe Railroad, on his recent visits to Europe to observe railroad operating conditions. He also told of his research on the predicting of Kansas weather, not for a few days ahead, but for years.

Christmas Party Held by Lehigh

A Christmas party was held by the LEHIGH BRANCH in cooperation with the industrial-engineering students of the school. Various kinds of gambling games were played with fake money and a valuable prize was awarded to the student having the largest sum at the end of the evening. Gifts were given to the members of the faculty, "who warranted them."

An interesting paper was presented on "The Manufacture of Heading" by Paul H. Sindo, student member, at a meeting of LOUISIANA STATE BRANCH.

LOUISVILLE BRANCH learned all about the development of aviation from Captain Williamson, U. S. Army, commander of Bowman Field, who stated that the airplane, as we know it today, was invented in 1903 by the Wright brothers.

Messrs. Harvey, Wanagel, and Haskell were appointed to the publicity committee by S. Vannah, chairman of the MAINE BRANCH.

Marquette Sees Cutaway Diesel

At a joint meeting of the MARQUETTE student branches of the A.S.M.E., A.I.Ch.E., A.S.C.E., and A.I.E.E. sponsored by the A.S.M.E. student branch, Ralph Hartzler and John Erskine of the International Harvester Co. presented an interesting program which featured an informal discussion by Mr. Erskine on the fundamentals of Diesel and other internal-combustion engines, a series of three sound motion pictures on the manufacturing, testing, and applications of Diesel engines, and an exhibition of a complete cutaway Diesel engine, a fuel injection pump, a glass-encased nozzle-testing outfit, a pressure-testing apparatus, and several types of engines. According to Paul C. Hoffman, secretary of the branch, the meeting was enjoyed immensely by the 160 members and guests present.

M.I.T. BRANCH heard a short lecture, and heard and saw a sound-motion picture on "Heat and Its Control" presented by G. W. Blakely, industrial engineer of the Johns-Manville Corporation.

Dean Anderson Awarded "Spoofuncup"

MICHIGAN BRANCH in a statement dated Dec. 15, 1937, announces that Dean H. C. Anderson,

member, A.S.M.E., was awarded that most famous trophy, the "Spoofuncup," by Prof. J. E. Emswiler, last year's recipient, in recognition of the dean's ability to take a "roasting" at the hands of the 100 or more students present at the annual Roast Banquet.

An inspection trip was made to a cement plant by members of MONTANA STATE BRANCH. Corry McDonald, secretary, says that each trip so far hasn't cost any member more than twenty-five cents.

Members of NEBRASKA BRANCH listened to an informal talk by Major Wood, U. S. Army, who discussed the problems encountered by the Army Engineer Corps in drafting plans for the Central Valley Project in California.

Operation and maintenance of the world's largest private motor-vehicle fleet was described at a meeting of NEWARK BRANCH by F. K. Glynn, engineer, A.T.&T.

Shoudy Talks to 75 N. Y. U. Students

N. Y. U. (evening) BRANCH considered itself fortunate to have W. A. Shoudy, member, A.S.M.E., speak at one of the meetings on the reasons for an engineering society and how membership in the society is one of the factors considered by employers when hiring engineers. He enlarged further on ways and means of obtaining positions, which proved very interesting to the 75 students present.

N. Y. U. (aeronautics) BRANCH members heard a valuable lecture on Fowler flaps given by Edward Wesserbe, a graduate student. The many questions asked Wesserbe by his audience proved the interest and importance of his topic.

NORTHEASTERN BRANCH had an instructive inspection trip to the Edgar Station of the Edison Co. in Weymouth.

PENN STATE BRANCH members learned all about motion-picture projectors and projection from Benjamin Saia, a student member, who has had many years of practical experience in the field.

N. C. State Welcomes Dean Van Leer

Members of NORTH CAROLINA STATE BRANCH and other students of the school consider themselves lucky in having secured Blake R. Van Leer, member, A.S.M.E., as dean of the engineering school. According to an article in *The Southern Engineer*, Dean Van Leer is especially interested in promoting graduate work. He believes that there is an increasing demand for more engineers with advanced training. He has also inaugurated a program of vocational guidance talks which will aid each freshman to adjust himself to his respective phase of engineering.

PRATT BRANCH had Henry Burns present a paper, "New Type of Seaplane Pontoon," which was followed by a splendid discussion in which all who were present took part. The branch also made a visit to the *New York Daily News* where they were privileged to see the inside workings of a big city newspaper.

Purdue Host to Sections

A dinner and meeting was arranged at PURDUE UNIVERSITY by the local sections of the A.S.M.E. and A.I.E.E. The guest of honor at the dinner was Wm. H. Harrison, president of the A.I.E.E. After the banquet, members were privileged to listen to C. M. Hathaway, General Electric Co., who gave an illustrated lecture on mechanical measurements by electrical means. Another account of the affair will be found in the local sections news in this issue.

Cider and doughnuts were served following a meeting of the RENSSELAER POLY BRANCH at which H. W. F. Green, Ludlum Steel Co., gave a worth-while talk on the manufacture and use of fine steels and metals.

ROSE POLY BRANCH had E. H. Eckerman discuss controllable-pitch propellers. Following this fine paper, C. J. Zinngrabe suggested that the branch demonstrate an electropainting process at the annual engineering show sponsored by the school.

Stevens First to Greet Dr. Davis

A very informal meeting was held by the STEVENS BRANCH at which the newly installed president of the A.S.M.E., Dr. Harvey N. Davis, was the guest of honor. The stand-by of most student branches, cider and doughnuts, was served to Dr. Davis, W. A. Shoudy, members, and other guests of the branch. A visit was made the following week to the new assembly plant of General Motors in Linden, N. J.

SYRACUSE BRANCH reports the appointment of John Bogdanoff, Arthur J. Wadsworth, William F. Boyle to the meetings and papers committee, and E. Fassler, E. P. Short, and Ronald Blair to the inspection-trips committee.

Dean Gilchrist Speaks

Claiming that TEXAS A. & M. COLLEGE is second only to Purdue in enrolled day engineering students, Dean Gibb Gilchrist, dean of the engineering school, spoke to 150 members and guests of the A.S.M.E. Student Branch, bringing out the fact of the need for more engineers to develop the many resources of Texas. The following week, 200 members and guests of the branch were fortunate in having Dean Gilchrist present a motion picture taken during the construction of the new highway running from Laredo, Texas, to Mexico City.

Texas Tech's Policy

TEXAS TECH BRANCH is continuing its very noteworthy policy of having papers presented by the members themselves. The subject of Bill Wright's paper at the last meeting was about what the engineer has done to make the modern automobile safer. Max Nuttall, who has been employed for several summers in a carbon-black plant in Texas, gave a brief description of the factory and the processes used.

Canadian Student-Meeting Plans

TORONTO STUDENT BRANCH, in preparation for the Student Meeting to be held at the school, starting May 1st, is already hard at work making plans for a most worth-while meeting. In general, the meeting will include two technical sessions, several interesting inspection trips, a dance, and an opportunity to compete for the Man-Miles Cup donated for the occasion by the Ontario Section. Details of the meeting will be published next month. However, planning for the meeting has not interrupted the excellent meetings held by the branch. In a symposium on lubrication, A. E. King presented the high-lights on the lubrication of ball and roller bearings, Q. A. Jackson talked on the lubrication of hypoid gears, and R. N. Boyd described the testing of oils.

TULANE BRANCH visited a sugar refinery where members observed the processes involved in making cane sugar. At a meeting the following week, Jacques Fortier reviewed plumbing as the Romans saw it, and Carl Hees talked on the 1938 automobiles.

Eggleston Visits Utah

After a very pleasant luncheon, O. C. Wilde, chairman of the UTAH BRANCH, introduced H. L. Eggleston, member of the Society's Committee on Local Sections, who stopped off in Salt Lake City on his way back to Los Angeles from the Annual Meeting in New York. In his brief talk, Mr. Eggleston emphasized the value of student activity in A.S.M.E. affairs. Two other visitors were W. H. Trask and W. D. Turpin, officers in the Utah Section.

VANDERBILT BRANCH is sponsoring an open house to bring the branch and its work to the attention of prospective members and future students in the school.

VERMONT BRANCH members visited a bakery where, much to their surprise, they found such machines as an automatic dough mixer, a special baking furnace, and a bread wrapper. At a meeting of the branch, Clinton A. Renfrew gave an illustrated lecture on pulverized-coal burners and their applications.

Washington University Has Mix-Up

WASHINGTON UNIVERSITY BRANCH reports that the Bureau of Mines sent it the wrong motion picture and consequently the members learned all about oil lands in Africa and Europe.

110 at Wisconsin Meeting

WISCONSIN BRANCH had 110 present at a meeting at which Mr. Lange, Timken Bearing Co., assisted by Mr. Curtiss and Mr. Vogt of the same company, presented a lecture on bearing development and usage.

YALE BRANCH heard A. R. Cohrane answer the question, "Is Big Business Growing"? and T. F. Wilson talk on "Frozen Foods and Fast Freezing." In the series of talks on various subjects sponsored by the branch, Dr. Clark L. Hull discussed "The Psychology of Suggestion" and Dr. L. W. Dobb talked on "The Psychology of Propaganda."

Novel College Employment Plan

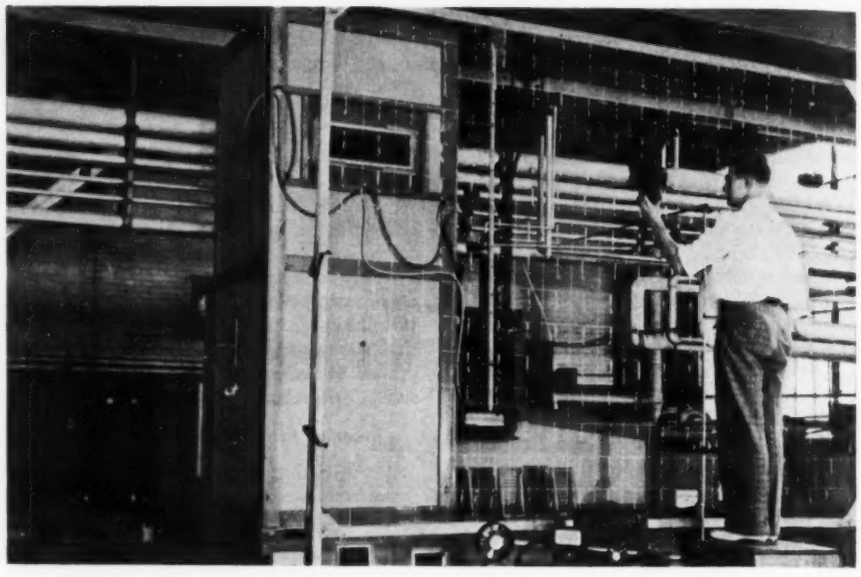
This year the College of Engineering of the STATE UNIVERSITY OF IOWA is inaugurating a plan of publishing a loose-leaf book containing a picture and personal information about each senior. Copies of the book have already been sent to several hundred prospective employers throughout the country. In addition, each senior has received 25 copies of his own record sheet to be attached to his letters of application. Information about the plan may be obtained from Prof. R. M. Barnes, member, A.S.M.E., and director of personnel, State University of Iowa, Iowa City, Iowa.

Schools Offer Courses in Air Conditioning Engineering

TO MEET the demands of the rapidly growing air-conditioning equipment manufacturers for specially trained engineers, many schools are offering courses in the subject as part of the regular engineering curriculum. Some schools, among which may be included the Case School of Applied Science, have built special laboratories for the study of the subject. At Columbia University, two evening courses in air conditioning are being offered for the third consecutive year.

Courses at Case are given as a part of the work in mechanical engineering and may be elected as an optional subject by members of the senior class. The work comprises three hours a week of lectures and recitations, and problems.

At Columbia, the courses are of approximately fifteen weeks' duration, and are offered in both the fall and spring sessions. Air conditioning I is a basic or general course, designed to present fundamental principles of air conditioning and of air-conditioning systems. Air-conditioning II is a technical course intended for advanced students.



THE USE OF GRILLES IN AIR CONDITIONING BEING STUDIED AT CASE IN AN ATTEMPT TO ARRIVE AT SOME SCIENTIFIC BASIS FOR AIR DISTRIBUTION

(A graduate assistant makes velocity and temperature measurements over a portable guide frame divided into 6-in. squares which can be set at various distances in front of the grille.)

The Members' Page

(*Continued from page 177*)

tional, state, and civic engineering works, and in the preparation of legislation pertaining thereto.

(8) Better selective methods of admission of students to engineering schools and the elevation of both entrance and graduation requirements.

(9) Supplementing the functions of educational, technical, and social engineering groups, societies, associations, or clubs by public, political, legal, welfare, employment, and similar activities designed to raise the economic status of the profession.

(10) Full cooperation with all engineering groups and individuals toward professional unity and solidarity throughout the entire profession, regardless of specialty of classification.

(11) Uniform and reciprocal improved state registration laws for professional engineers.

(12) Legislation on behalf of the profession and organized opposition to any legislative action tending to deprive the engineer of any of his professional rights.

I do not know that the Founder Societies have accomplished anything of note along these lines, nor do I consider it amiss if they have not. I do not consider these objectives necessarily a proper function of a purely technical group depending in a large part upon corporate-employer assistance for the continuation of their technical developments.

I would earnestly deprecate any attempt such as Mr. Hescheles suggests toward making the individual technical societies part of a unified conglomeration. They have developed to a high state of perfection along specialized lines and they should not lose their identity or corporation support.

On the other hand, the National Society of Professional Engineers, embracing all divisions of the profession for economic and public purposes, with the direct welfare and public recognition of the engineer and the elevation of the profession among its avowed aims, should remain an independent society *of* the engineers, *by* the engineers, and *for* the engineers with a purely democratic organization. It should enter into no union with any other groups subsidized, no matter how indirectly, by corporate interests.

I in no way intend to infer the existence or possibility of any opposition or conflict between the interests of the engineer and those of the employer corporations; they are interdependent, but I feel that the only way for an independent society of professional engineers to retain a free hand for carrying out its purpose of being is to avoid any such merger, while remaining actively cooperative in all friendliness with the other engineering, educational, manufacturing, and business groups.

The idea of combining all the 100 odd engineering societies into one big society is attractive and certainly Utopian and also somewhat reminiscent of the I.W.W. With our political economy, it seems that such a combination, even if possible, must certainly do more harm than good. It might be feasible in a communist or fascist state, it might possibly be advantageous under such régimes. However, under our form of government pledged to individual independence and constitutional rights, it would be impracticable to get all these various groups having such varied financial, technical, professional, social, and functional aspects to give up part of their purposes and prerogatives and sacrifice their dentities in the merger.

It may be cheaper and save time for a number of families to live together in communalism but this has its offsetting disadvantages and most of us still prefer a separate existence of some sort, however humble or inefficient. With societies or clubs of similar character, whose reasons for being are almost identical, their members rarely will voluntarily consent to a merger, although such conjunctions sometimes happen necessarily under the drive of financial difficulties.

HARRY E. HARRIS.[1]

[1] Consulting Engineer, Bridgeport, Conn. Life Member, A.S.M.E.

Other Engineering Activities

Guggenheim Medal Awarded to Hugo Eckener

Orville Wright and Colonel Lindbergh Present at Honors Night of Institute of the Aeronautical Sciences

INAUGURATING an annual event to commemorate the first flights of the Wright brothers at Kitty Hawk in 1903, the Institute of the Aeronautical Sciences held its first Honors Night on Dec. 17, 1937, at the Hotel Biltmore in New York City. High points of the meeting were the awarding of the Guggenheim Medal to Hugo Eckener, veteran airship builder, and the presence of the two most famous characters of American aviation, Orville Wright and Col. Charles A. Lindbergh. Presiding at the meeting was the Honorable Harry F. Guggenheim, former president of the Daniel Guggenheim Fund for the Promotion of Aeronautics. Among those present at this significant meeting were the following guests and members of the Institute: Dr. Clark B. Millikan, president of the Institute, Dr. Harvey N. Davis, president of the A.S.M.E., Dr. Orville Wright and Dr. William F. Durand, honorary members of the A.S.M.E., T. P. Wright, Edw. P. Warner, and Elmer A. Sperry, Jr., members of the A.S.M.E., Glenn L Martin, Major-General O. Westover, Commander Charles E. Rosendahl, Colonel Charles A. Lindbergh, Dr. Lyman J. Briggs, Dr. W. R. Gregg, Dr. George W. Lewis, Eastman N. Jacobs, C. L. Johnson, Philip B. Taylor, B. C. Boulton, and Prof. B. Melvill Jones, of Cambridge University.

Opening the meeting with a few introductory remarks, Doctor Millikan stated that the occasion was significant in many ways, first, it marked the 34th anniversary of the Wright brothers' first flights, second it was the first time in which the Daniel Guggenheim Medal, the Reed and Sperry awards, and honorary fellowships and memberships in the Institute, were bestowed on the recipients at one meeting, and finally it gave American scientists an opportunity to honor Prof. B. Melvill Jones, and to thank him for coming from England to give the initial Wright Brothers' Lecture, which was delivered that afternoon at Columbia University. He then introduced Mr. Guggenheim who acted as chairman of the meeting.

HARVEY N. DAVIS ANNOUNCES AWARD TO HUGO ECKENER

The chairman introduced T. P. Wright, president of the Board of Award of the Daniel Guggenheim Medal, who explained the purpose of the medal and how it was made possible out of a fund administered jointly by The American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Institute of the Aeronautical Sciences. Dr. Harvey N. Davis announced the presentation of the 1937 Guggenheim Medal to Dr. Hugo Eckener of Germany "for notable contributions to transoceanic transport and to international cooperation in aeronautics." The award was accepted on behalf of Dr. Eckener by Charles E. Rosendahl, commandant of the Lakehurst, N. J., Naval Air Station,

HUGO ECKENER AWARDED GUGGENHEIM MEDAL

B. MELVILL JONES DELIVERS FIRST WRIGHT BROTHERS LECTURE

who read a cable and a letter of thanks and acceptance from Count von Zeppelin's successor. The cable reads as follows:

> "Unfortunately on account of not quite satisfactory health am compelled to renounce personally attending your meeting. Permit me to express by cable my high appreciation of the great honor bestowed on me with the award of the Daniel Guggenheim Medal."

In the following letter, Dr. Eckener reveals the great loss and hurt to his morale when he heard of the disaster. However, he and his associates refused to admit defeat and are now building a helium-filled Zeppelin to take the place of the ill-fated ship which was lost at Lakehurst.

DR. ECKENER'S GREETINGS FROM FRIEDRICHSCHAFEN

In all truthfulness I can say that rarely, if ever, have I been more pleased over any distinction or token of appreciation that has been accorded me for my activities in the field of lighter-than-air aeronautics than over this award of the Guggenheim Medal. This great pleasure and appreciation has for its basis two reasons. First, I fully appreciate the high honor which this award carries with it; and second, I was especially gratified at the propitious time chosen for making this award to me. I was informed of this great honor immediately after the *Hindenburg* catastrophe. I believe I am justified, therefore, in interpreting this award not only as a token of appreciation of past service, but also as an encouragement and a challenge to continue in my work. This was of great value to my morale. It can probably be understood, and I readily admit, that in the first moments following the tragic happening at Lakehurst, which came so unexpectedly after hundreds of happy voyages, I felt a deep loss, and almost began to doubt whether the Zeppelin idea could still be carried on. The award of the Guggenheim Medal, therefore, in these hours of greatest sorrow, seemed to me like help from friends who rescued me from the deepest discouragement.

But calm consideration and exact calculations very soon proved that the *Hindenburg* catastrophe in no way spelled the end of Zeppelin airships. Perhaps I may be permitted to say a few words along this line before this illustrious gathering.

It was immediately evident that a continuation of Zeppelin operations was out of the question with ships inflated with hydrogen; on this point, I am sure, I do not have to elaborate. Of necessity we had to go to the use of the noninflammable helium. The first problem was therefore; Is it possible to obtain sufficient quantities of helium? As you know, helium exists in the oil fields of Texas and Colorado in practically unlimited quantities, and therefore, it was only necessary to obtain authority for the export of helium for use in commercial airships. I am happy to be able to acknowledge here most gratefully that the President and Congress of the United States, in the generous spirit of their "good neighbor" policy and with great vision toward the future, initiated and enacted legislation which makes safe helium gas available for the purpose of international commercial airship transportation. Your government's indication of its willingness to share the benefits of this safe gas has given us the necessary fundamental and positive decision, which allows us to carry on.

Immediately another problem arose, one of a technical nature: When using helium as lifting gas, would lighter-than-air ships be commercially economical? Produced in the modest quantities of today, helium is about ten times as expensive as hydrogen Therefore, would its use be prohibitive? It was clear that the lavish squandering of an airship's lifting gas, as was the practice with the cheaper hydrogen, could no longer be indulged in. It would be necessary to some extent to modify our operating technique.

It is a well-known fact that the system of so-called "water-recovery" is the deciding factor with which this problem can be solved.

While in hydrogen operation, the weight of fuel consumed in the motors is balanced by deliberately valving or releasing a compensating amount of lifting gas, it will be necessary in helium operation, to create this balance by water-ballast recovery from the exhaust gases. I should like to state here that our tests in Friedrichshafen have shown that it is possible to recover a sufficient quantity of water ballast from the exhaust gases of the Diesel engines which we employ.

With this, the deciding factor has been obtained; but additional steps must be taken to avoid other losses of helium. When using hydrogen, airships took off from the surface fully or nearly fully inflated. This, however, entailed an immediate loss of lifting gas through valving, until the necessary flying altitude had been reached. To fly over low mountain ranges, this altitude must be at least 1900 to 2300 ft, and it was therefore necessary to provide suitable measures for reaching such altitudes without expensive loss of gas. It is possible by preheating the lifting gas before the ascent to rise with the ship not fully inflated; at the lower temperatures of flying altitudes, the preheated gas cools off rapidly to outside temperatures in flight, and the ship may reach the required flying altitude without appreciable loss of gas. Tests made in Friedrichshafen have shown that this problem of preheating also can be easily solved.

The situation then is as follows: With these two means at our disposal, namely water recovery and preheating of the gas, it will be possible in the future to carry out ocean voyages without losses of helium by valving. Except for losses through inevitable incidents, helium should not be lost, except through unavoidable diffusion and in purification. These losses, however, are expected to be kept so low that they should not exceed 10 per cent of the total losses we have had in hydrogen operation. This would mean that helium operation essentially should not be higher in cost than hydrogen operation.

This finding, therefore, is of the greatest importance for the future development of airships. It is self-evident that airship transportation can be maintained and survive only if it is economical and self-supporting. One cannot keep it alive indefinitely with money out of the pockets of the taxpayers; this is necessary and justified only during the first years of development. The ten demonstration round trips of the *Hindenburg* in 1936, however, proved that with an average booking of 70 to 75 passengers at a rate only little above the average cost of a first-cabin passage on an express steamer, it is possible to have self-supporting airship transportation. It should not be difficult to maintain bookings of 70 to 75 passengers, especially on future helium-filled airships which guarantee a maximum of safety. It is well known that many travelers refrained from using the airship previously because of its inflation with hydrogen.

In conclusion, let me say that just as has been the case in comparable tragedies in other modes of transportation, the tragic *Hindenburg* catastrophe, terrible and deplorable as it was, has actually brought about tremendous progress in the safety of this modern means of transportation. Only now, with helium assured, are we fully convinced and justified in advocating the Zeppelin airship as a means of transportation. I, for one, will continue to do so wholeheartedly, and I wish to thank you for the precious medal which will inspire me further.

More than ever is it necessary today to work for everything that may bring peoples and nations closer to each other; and this means first of all the development of commerce and transportation, which in the end—I am positively convinced—will finally triumph over all that which now separates peoples and nations in an atmosphere of chauvinism.

MANY A.S.M.E. MEMBERS HONORED

Other recipients of the Daniel Guggenheim Medal have been: Orville Wright, honorary member A.S.M.E., for the design and construction, with his brother, of the first successful engine-propelled airplane; Ludwig Prandtl, of Germany, for his pioneer and creative work in the theory of dynamics; Frederick W. Lancaster, of England, for his contributions to the fundamental theory of aerodynamics; Juan de la Cierva, of Spain, for his development of the theory and practice of the autogiro; Jerome C. Hunsaker, member A.S.M.E., for his contributions to the science of aerodynamics, to the science and art of aircraft design, and to the practical construction and commercial utilization of rigid airships; William E. Boeing, for his successful pioneering and achievement in aircraft manufacturing and air transport; William F. Durand, honorary member A.S.M.E., for his notable achievement as a pioneer in laboratory research and theory of aeronautics, and his distinguished contributions to the theory and development of aircraft propellers; and George W. Lewis for his outstanding success in the direction of aeronautical research and for his development of original equipment and methods as director of aeronautical research for the National Advisory Committee for Aeronautics.

The Sylvanus Albert Reed Award for 1937, established in 1934 to be given "for notable contribution to the aeronautical sciences resulting from experimental or theoretical investigation," was presented at the meeting by Edward P. Warner, member A.S.M.E., to Eastman N. Jacobs, an aeronautical engineer on the staff of the N.A.C.A. "for his contribution to the aerodynamic improvement of airfoils used in modern military and commercial aircraft." Elmer A. Sperry, Jr., made the presentation of the Lawrence B. Sperry Memorial Award for 1937 to Clarence L. Johnson, who graduated from the University of Michigan in 1933 and joined the Lockheed Aircraft Corporation where he has been in charge of all research and test work on the transport planes developed by the company.

Honorary fellowships in the Institute of the Aeronautical Sciences were awarded to Prof. B. Melvill Jones, the first Wright Brothers Lecturer, "for contributions to the science of aeronautics, for introducing the conception of the streamlined airplane, and for full-scale research on boundary-layer flow," and to Glenn L. Martin "for his outstanding achievement in the construction of notable aircraft of all types." Only two honorary fellowships, one American and one foreign, may be given each year by the Institute.

The ten fellows elected for 1937 by the other fellows of the Institute are: Lieut.-Comdr. Ralph S. Barnaby, member A.S.M.E., B. C. Boulton, Karl T. Compton, member A.S.M.E., A. V. de Forest, E. P. Lesley, A. A. Priester, Comdr. Charles E. Rosendahl, C.-G. Rossby, Philip B. Taylor, and L. B. Tuckerman. Honorary memberships in the Institute were bestowed on Lyman J. Briggs, Rear-Admiral A. B. Cook, Fred D. Fagg, Jr., W. R. Gregg, Hon. Harry F. Guggenheim, George W. Lewis, Major-General O. Westover, and H. E. Wimperis, president of the Royal Aeronautical Society.

During the meeting a cable was received from the Royal Aeronautical Society announcing the award of the 1937 Taylor Gold Medal to George J. Mead, member A.S.M.E. and vice-president of the United Aircraft Corporation, for his paper "Power-Plant Trends" presented before the society on April 22, 1937. Mr. Guggenheim read the cable and Mr. Mead, who was present, acknowledged the applause of the audience.

Dr. Durand closed the program with an appreciation of the work of the Wright brothers. Following the meeting, a collation was served during which those present had an opportunity to greet friends and to congratulate the recipients of awards.

B. MELVILL JONES DELIVERS FIRST WRIGHT BROTHERS LECTURE

The first annual Wright Brothers Lecture was given in the afternoon by Prof. B. Melvill Jones on "Boundary-Layer Experiments in Flight" at the Pupin Physics Laboratories, Columbia University. The lecture was established by the Institute of the Aeronautical Sciences with the approval of Orville Wright as a companion lecture to the Wilbur Wright Lecture instituted by the Royal Aeronautical Society. An American and a foreign guest will alternate each year in presenting the Wright Brothers Lecture on December 17. The purpose of the lecture is to emphasize the scientific and technical side of the Wright brothers' work which is not as well-known as their construction and piloting achievements.

Professor Jones is the Francis Mond Professor of Aeronautical Engineering at Cambridge University, England. He was on the staff of the Aerodynamics Department of the National Physical Laboratory during its early years. During the war he was an aerial gunner and was also engaged on full-scale armament experiments. He has been a member of the British Aeronautical Research Committee since 1919. His recent research work has related mainly to flight experiments on the control of airplanes at low speeds and the drag of smooth streamline airplanes.

Talking before an audience of more than 200 engineers, scientists, and students, which also included Nicholas Murray Butler, president of Columbia University, and Orville Wright, Professor Jones discussed the results of experiments in flight dealing with laminar and turbulent flow over airfoils and wings of airplanes. This study was for the purpose of det rmining the transition point or points where the smooth laminar flow changed to a turbulent flow, the amount and depth of such turbulent flow being the determining factor of the drag imposed on the structure by air currents. This is a continuation of the work started by Professor Jones in 1929 aimed toward the reduction of drag of airplanes by proper streamlining. Since that time, designers and engineers have utilized his findings extensively and built

airplanes which waste only 25 per cent of the horsepower developed by the engines in overcoming friction drag produced by surfaces, instead of the 66 per cent waste in 1929.

It is Professor Jones' theory that if a means could be developed to move the transition point backward, thus making for a greater proportion of laminar flow over the surface than turbulent flow, drag would be reduced and the speed of the airplane increased. He showed that by making the surface absolutely smooth this transition point has been made to move back to 35 per cent of the width of the wing as against the 5 to 10 per cent usually maintained in actual practice. In one test on a very smooth wing, the presence of a piece of tinfoil one five hundredth of an inch thick was sufficient to move the transition point forward and slightly increase the friction drag. In another test, the presence of mist on the wing due to flying through a cloud brought about a similar result. He found that tests in flight, where the air is smooth and free from turbulence, were necessary in order to obtain these results because the slight unsteadiness generally present in the flow in wind tunnels is sufficient to move the transition point forward.

According to the discussers of Professor Jones' paper, which included B. C. Boulton, Hugh L. Dryden, W. F. Durand, J. C. Hunsaker, George W. Lewis, Igor I. Sikorsky, Eastman N. Jacobs, and T. P. Wright, he brought out clearly the results of the flight experiments made and of the effect which the variables so far investigated, such as scale, pressure gradient, and radius of curvature, have on the transition point and, therefore, the drag.

He concluded that these variables alone are not determining and felt that some additional quality of the flow caused by the wing itself has yet to be found before the phenomenon of the transition point can be fully explained. As in all scientific work, he intends to proceed with further experiments with a view to solving the problem, perhaps dealing next with certain minute fluctuations which have been observed by American scientists in the flow of the laminar boundary layer.

The Engineering Foundation Reviews Year's Progress

Large Number of Specific Problems Being Studied

REVIEWING the progress made during the fiscal year ending Sept. 31, 1937, The Engineering Foundation presented its annual report at the annual meeting of the United Engineering Trustees, Inc., on Oct. 28, 1937. The deaths of two important members of the foundation are recorded, namely, Dr. Alfred D. Flinn, secretary and director since 1917, who died March 14, 1937, and Dr. Ambrose Swasey, founder of the foundation in 1914 "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind," who died June 15, 1937.

F. M. Farmer, chairman of the Foundation, reports that a large number of specific problems (about 33) are being studied over a wide range of fields. It is believed that this policy is more effective in carrying out one of the purposes of the Foundation, namely, "the furtherance of research in science and engineering." The following is a brief summary of activities sponsored by the A.S.M.E. which have been aided during the year.

Cutting Fluids. Experimental work at the University of Michigan was completed on monel metal and reported in a paper by Prof. O. W. Boston and Dr. W. W. Gilbert in the November, 1936, issue of Transactions. Work is now being conducted on S.A.E. 2345 steel. Professor Boston presented a paper on his work on this project before the Institution of Mechanical Engineers in London, October, 1937, and also before the Congress of the International Association for Testing Materials in London, April, 1937.

Critical Pressure Steam Boilers. This project has been under way at Purdue University for some time, the present program being the reaction between steam and metals at high temperatures. A report of the progress made was reported in Transactions for November, 1937, by Dean A. A. Potter, Prof. H. L. Solberg, and Prof. G. A. Hawkins.

Fluid Meters. The present experimental program is on flow nozzles, an investigation which has been under way at the National Bureau of Standards, Washington, D. C., for some time, and is expected to be completed in about three years. Articles concerning this study have appeared in a number of technical journals and a paper was presented at the 1937 Annual Meeting of the A.S.M.E. by H. S. Bean and S. R. Beitler.

Strength of Gear Teeth. Twelve test runs have been made on a special surface-fatigue-testing machine by Prof. Earle Buckingham at Massachusetts Institute of Technology. A progress report by Professor Buckingham was published in the August, 1937, issue of MECHANICAL ENGINEERING.

Lubrication. This project, under a special research committee headed by Prof. G. B. Karelitz of Columbia University, has included the compilation of a bibliography on lubrication, a study of the problem of viscosity of lubricants under pressure, and investigation of increased viscosity under high pressure in bearing oil films. One paper by Professor Karelitz and J. N. Kenyon was published in the April, 1937, issue of Transactions and another one was presented before the Institution of Mechanical Engineers in London, October, 1937.

Effect of Temperature on the Properties of Metals. This extensive project which has been under way for some years under the direction of a joint committee, the Foundation's contribution to which is a very small amount, was reorganized during the year, however, a total of nine research projects, either new or already under way, were prosecuted during the year. Under the chairmanship of H. J. French, most of the work has been carried on at the Battelle Memorial Institute and the University of Illinois.

Engineers' Council for Professional Development. The death of General R. I. Rees has interfered with the carrying on of the work at the rate contemplated; nevertheless, much progress has been made under the chairmanship of Prof. Chas. F. Scott. The "Accrediting Schools" project has been highly successful so that during the year the perplexing problem of accrediting engineering education has been definitely solved. The total of degree-granting schools that have been inspected to date is 134. A complete report of the Council's work and a list of the schools accredited were published in the December, 1937, issue of MECHANICAL ENGINEERING. Some of the Foundation funds were used for the general overhead expenses of this project but the cost of activity itself is self-liquidating from the fees paid by the schools, which to date have totaled about $30,000.

A study of the "Evaluation of Professional Qualifications" is still under way under the direction of Dean Barker of Columbia University. A study has been made of certain "Aptitude Tests" in 12 institutions which has confirmed previous reports that lack of schooling, essential to engineering, can be detected by these tests.

According to F. M. Farmer, these reports give ample evidence of enthusiastic, unselfish interest on the part of the research workers in these projects and it is certain that the stimulation of such efforts by the relatively meager funds supplied by the Foundation is well justified; particularly when it is noted that in the majority of cases the money and services supplied from other sources is many times that of the amount contributed by the Foundation.

Seventh International Management Congress

AMERICAN commerce, industry, and finance are cooperating to make the Seventh International Management Congress, scheduled to be held in Washington, D. C., September 19–23, 1938, an occasion "to dramatize before a world-wide audience the contributions made by management under a system of free enterprise to the rising standards of living of our people."

In the bulletin of the congress, the following objectives are stated:

1 To provide a forum for interchanging world experience in all phases of management, thereby aiding the economical production and distribution of goods and services in industry and agriculture, and increasing the satisfaction of using the resultant benefits in the home.

2 To give management in industry and agriculture a needed opportunity to appraise the social and economic results of its work, and discern its future course under rapidly

changing conditions and new concepts of its responsibility.

3 To give leaders of thought and action the opportunity to advise management in its relations with the public, labor, and government.

4 To give management an opportunity to rededicate itself publicly to the principles and practices that are easing daily labors, spreading the advantages of widely distributed goods, and promoting the well-being of the peoples of the earth.

Four tours, conducting about 500 foreign delegates expected to attend the congress through factories and offices in which the latest methods of American business management may be seen, have been arranged by the Social and Tours Committee of the congress, of which L. C. Morrow, chairman of Management Division, A.S.M.E., is a member. Mr. Morrow is chairman of the Objectives and Program Committee which is responsible for the general sessions.

Technical Steel Board Formed

C. T. Ripley, Chief Engineer

THE AMERICAN Rolling Mill Co., Bethlehem Steel Co., Carnegie-Illinois Corp., Edgewater Steel Co., and Standard Steel Works Co. have formed what will be known as the Technical Board of the Wrought Steel Wheel Industry.

The purpose of the board is to organize and coordinate the approach to difficult technical problems due to growing difficulties in requirements of railroad service, to collect complete information on the performance of wheels, and to provide channels of communication between steel-wheel manufacturers and the railroads on engineering problems.

Charles T. Ripley, member, A.S.M.E., widely known to officials and engineers in the railroad business as former chief mechanical engineer of the Atchison, Topeka and Sante Fé Railroad, has been appointed chief engineer of the technical board. With headquarters in Chicago, he and his staff will conduct technical research and development in design, manufacture, application, and service of wrought-steel wheels.

S.A.E. Annual Meeting, Detroit, Jan. 10–14

THE SOCIETY of Automotive Engineers held its annual meeting in Detroit at the Book-Cadillac Hotel, Jan. 10–14, 1938. At the annual dinner held on Thursday, January 13, C. W. Spicer, member, A.S.M.E., was installed as president of the society for the year 1938. C. F. Kettering, another A.S.M.E. member, discussed "The Philosophy of Research."

Papers discussing the many technical problems of the automotive industry were presented at sessions covering transportation and maintenance, aerodynamics, aircraft instrument landing, truck, bus and railcar, aircraft engines, passenger-car safety, passenger-car and body, production, Diesel engines, and fuels and lubricants. An automotive-engineering display, for which 35 automobile and parts manufacturers provided exhibits, was another feature of the meeting.

Stainless-Steel Exposition at New York Museum

AN EXPOSITION of stainless steel has just opened for a period of several months in the New York Museum of Science and Industry, R.C.A. Building, Rockefeller Center, New York City. Every aspect of stainless steel, its history, development, production, fabrication, and uses, is portrayed in a comprehensive, interesting, and educational manner. The display includes hundreds of stainless-steel products sent to the exhibit by manufacturers from all over the United States.

The fields of application receiving especial emphasis are the household, the food and beverage industries, general industry, transportation, architecture, and the medical and dental professions. The displays of stainless-steel products are supplemented by motion pictures and demonstrations showing why stainless steel is an important contribution to mankind, its usefulness in the food industry, its adaptability for strong, lightweight structures and for high-temperature service, and its importance in architectural applications.

Armour Institute Offers Conference Course for Executives

THE second annual series of weekly conference courses for executives and engineers was started on January 17, 1938, by the Armour Institute of Technology, Chicago, Ill. The subject of the present series of courses has been chosen to deal with "Executive Control of Personnel."

Among the speakers scheduled are Donald Richberg, former director of the N.R.A., Harold B. Bergen, member of the A.S.M.E., Glenn L. Gardiner, Johnson O'Connor, director of the Human Engineering Laboratory of Stevens Institute, Morris Greenberg, vice-president of Hart, Schaffner & Marx, John Stephens, manager of industrial relations for the Carnegie-Illinois Steel Company, R. W. Stone of the University of Chicago, Stanley P. Farwell of the Business Research Corporation, F. J. Roethlisberger of Harvard University, and H. R. McCarthy, regional director of the Social Security Board.

The series as a whole will deal with the problems of industrial relations resulting from rapid changes in the general economic and social outlook. Designed especially to meet the needs of operating executives, the emphasis will be on an exchange of practical experiences and a stimulus to fresh thinking in this changing field. Last year's conference courses on plant engineering and maintenance proved the effectiveness of this method of reaching busy men.

Texas Tech Sponsors Welding Conference

MEMBERS of the A.S.M.E. are invited to attend the third welding conference sponsored by Texas Technological College, Lubbock, Texas, for February 3–4, 1938. According to a tentative program, lectures illustrated with motion pictures and slides will be conducted in the mornings. After luncheon, manufacturers of electric and oxyacetylene-welding equipment will exhibit and demonstrate their equipment. A banquet followed by a round-table discussion has been scheduled for the evening of February 3. There is no charge for registration for the conference. Ample hotel accommodations at reasonable rates are available.

American Welding Society Sponsors Lecture Course

SPONSORED by the New York section of the American Welding Society, the second annual series of lectures on welding was opened on Tuesday, January 11, 1938, at the Polytechnic Institute of Brooklyn. This year's course, dealing principally with the fundamentals of welding design, consists of a series of ten weekly lectures.

(*A.S.M.E. News continued on page 192*)

Consulting-Engineers Council Approves Policy Regarding Competition of Schools

THE Council of the American Institute of Consulting Engineers recently approved the report presented to it on Sept. 8, 1937, by Dugald C. Jackson, chairman of the Special Committee to Consider Competition Offered by Educational Institutions. The policy accepted by the Institute is expressed in the following from the report: "It is our opinion that the drastic restriction relating to educational institutions which is proposed by others would be disadvantageous to American industries and American engineering if put into effect and it is our recommendation that the Council of the American Institute of Consulting Engineers should refrain from taking an attitude antagonistic toward educational institutions (and endowed institutions in general) undertaking investigations of a scientific nature for commercial organizations and for immediate commercial purposes; but that our Council should take the position that each such institution is under a moral obligation to make appropriate charges for such work of a commercial character, which charges include appropriate amounts to cover compensation for members of the staff called upon in the work, appropriate compensation for the responsibility assumed through carrying on the work, and proper amounts to cover over-head costs as well as the direct operating expenses."

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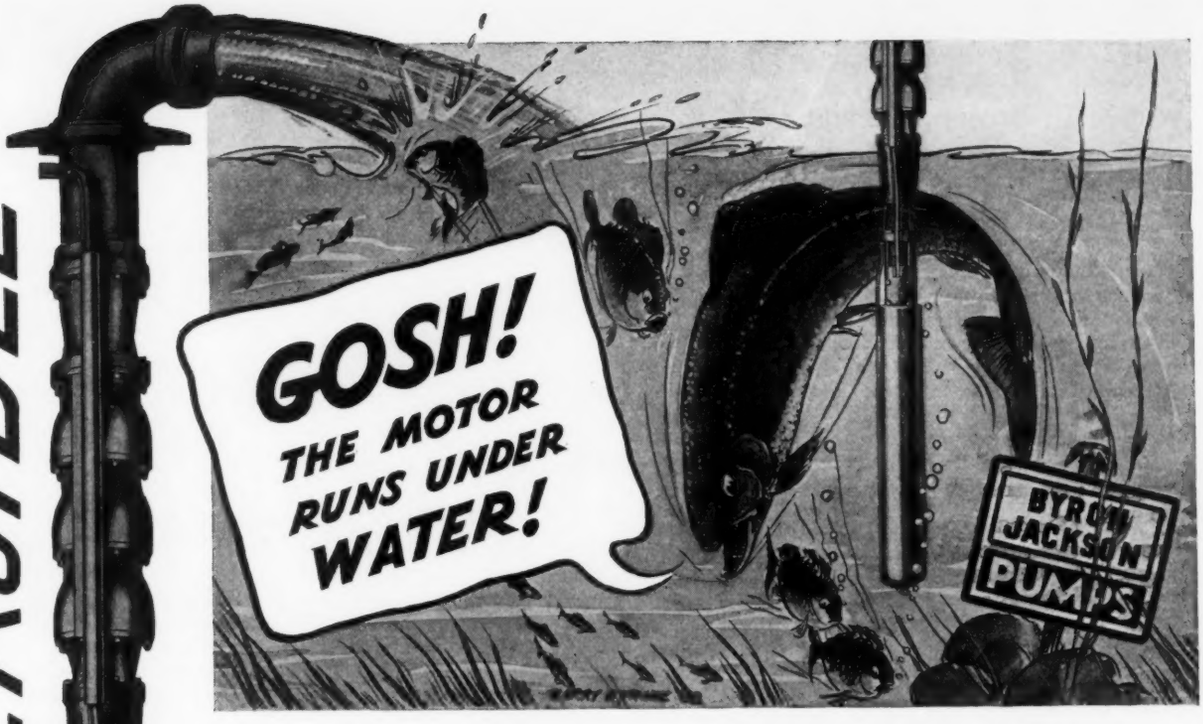

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W. V. Brown, Manager of Employment Service, Is Honored

WALTER VAIL BROWN became manager of the Engineering Societies Employment Service in April, 1918, twenty years ago this spring. During this time he has played a prominent part in the development of the Employment Service from a so-called clearing house of information regarding engineering positions available to a modern employment service catering to the needs of the membership of the four Founder Societies.

In the beginning, the Service was undertaken as a joint activity under the immediate supervision of the United Engineering Societies. When the American Engineering Council was formed it was administered by that organization, then known as the Federated American Engineering Societies, for a period of nearly two years. About 1923 it was returned to the direction of the Founder Societies under the general supervision of a National Board composed of the Secretaries of the respective Societies.

Mr. Brown, an alumnus of Massachusetts Institute of Technology, has been manager of the New York office during this entire period, and in recognition of his loyalty and efficient service he was tendered a luncheon at the Engineers' Club on January 6 at which he was presented with life membership in the American Institute of Electrical Engineers of which he has been a member since 1921. His legion of friends which include those whom he has been instrumental in serving through the medium of the Employment Service will, no doubt, be interested in this recognition for his painstaking efforts for the past generation.

The British Industries Fair, Feb. 21–Mar. 4, 1938

THE BRITISH Industries Fair will be held from Feb. 21 to Mar. 4, 1938, with nearly a million square feet of space allotted to exhibitors in London and Birmingham. One of the many features at the fair will be the first showing of a new instrument which will enable engineers to test the hardness and wearing properties of various metals, and also the effect of such wear on different grades of oils.

A.M.A. Annual Personnel Conference, Chicago, Feb. 15–17, 1938

INDUSTRIAL problems are to be discussed on February 15 to 17, 1938, when the American Management Association holds its annual personnel conference at the Palmer House in Chicago.

More than 1000 industrial-relations executives are expected to attend the conference which will be dedicated to "Securing Industrial Peace." The conference committee is building the program from the viewpoint of the "reconstruction phase" of labor relations. While cognizant of the fact that industrial tranquillity has by no means been achieved, the committee has pointed out that there has been a subsidence in the violence of strikes, and that, more important, there is fundamental difference in the character of labor strife of recent months and that which prevailed a year ago. The important problem at present is to insure the permanency of what peace has been achieved, and to extend this peace further into those industries and those phases of industrial relations which are still unsettled.

L. K. Sillcox Appointed to Monographs Committee

L. K. SILLCOX was appointed a member of the Engineering Societies Monographs Committee, a joint activity of the United Engineering Trustees, Inc., on which the four Founder Societies are represented. As a representative of the A.S.M.E., Mr. Sillcox will also represent its Standing Committee on Professional Divisions.

A.I.M.E. Honors Doherty

AT THE annual meeting of the American Institute of Mining and Metallurgical Engineers, Feb. 14–18, 1938, Henry L. Doherty, member, A.S.M.E., will be honored when he is presented with the Anthony F. Lucas Medal in recognition of his discovery that natural gas is vitally important in mining petroleum. The gold medal will be formally presented at the Institute's annual dinner on Feb. 16, 1938. The award is given in memory of the late Captain Lucas, discoverer of the "Lucas Gusher" in 1901 at Spindletop, Texas.

"Journal of Applied Physics" Offers Sample Copies

MENTION was made in the December, 1937, issue of MECHANICAL ENGINEERING that the *Journal of Applied Physics* was offered to members of The American Society of Mechanical Engineers at a special rate of $5.00 a year instead of the regular rate of $7.00. The American Institute of Physics, 175 Fifth Avenue, New York, N. Y., which publishes this *Journal*, has further offered to send a limited number of sample copies, on request by members of the Society so that they may judge its value before subscribing.

University of Wisconsin in Joint Session With A.F.A.

A CONFERENCE on foundry problems will be held jointly by the Mining and Metallurgical School of the University of Wisconsin and the Milwaukee Chapter of the American Foundrymen's Association at the Hotel Schroeder, Milwaukee, Wisconsin, February 3 and 4, 1938. The two-day conference will consist of a series of simultaneous sessions on steel, malleable, gray iron, and nonferrous foundry problems. In general, the subjects to be covered by each of the discussion groups will be as follows: melting, casting, sand, special metals, apprentice training, and foundry management.

Local Sections

Coming Meetings

Anthracite-Lehigh Valley: February 25. Pottsville, Pa., at 8:00 p.m. Subjects: "Creep of Steels at High Temperature," by P. G. McVetty, Research Laboratories, mechanics division Westinghouse Electric & Mfg. Co.; "Fatigue of Metals," by Dr. O. J. Horger, research engineer of the Timken Roller Bearing Co., Canton, Ohio.

Baltimore: February 10. The Engineers Club, Baltimore, Md., at 8:15 p.m. Subject: "The Development of Mechanical Rubber Goods and Uses of Rubber in Manufacturing Processes," by H. E. Morse, manager, mechanical-goods development department, Goodyear Tire & Rubber Co.

Cleveland: March 8. Guild Hall at 8:00 p.m. Subject: "Republic Steels' 98-In. Strip Mill," by H. B. Carpenter, district manager, Republic Steel Corporation. Subjects of papers by students of the University of Dayton: "A Graduate's Outlook," by D. P. McCrate; "Popular Treatment of the P.C.C. Street Car," by Wm. M. Schroeder; "Model Airplane Design," by B. F. Hollenkamp; "The Demand for Comfort Cooling," by J. M. Leonard; "Engineering Development of Manchukuo," by L. J. Darbier. An inspection tour through the engineering laboratories with the students serving as guides will conclude the program.

Detroit: February 15. "Developments in the Design and Use of Gaging Equipment," by C. V. Johnson, Pratt & Whitney Division, Niles-Bement-Pond Company.

Ontario: February 10. Hart House, University of Toronto, Toronto, Ontario, at 6:30 to 7:30 p.m. The subject is undecided but it will deal with some phase of professional training by F. E. Searle, superintendent, Henry Ford Trade School, Dearborn, Mich.

Providence: February 1. Providence Engineering Society Building at 8:00 p.m. Subject: "New Developments in Machine Tools," by Tell Berna, general manager, National Machine Tool Builders Association.

San Francisco: February 24. Engineers Club at 6:00 p.m. Subject: "Mining in California—Mechanical-Engineering Aspects of Placer Mining and Dredging," by H. A. Sawin, sales engineer, Yuba Manufacturing Co., San Francisco, Calif., and V. E. Bramming, Pan-American Engineering Company, Berkeley, Calif.

Worcester: February 14. Sanford Riley Hall, Worcester Polytechnic Institute—Dinner at 6:45 p.m., meeting at 7:45 p.m. Subject: "Loxology," by Maxwell C. Maxwell, assistant to the president, Yale & Towne Mfg. Co.

(*A.S.M.E. News continued on page 194*)

Are you accepting the challenge of COR-TEN ?

FOR years engineers and designers have said "Give us a steel that is stronger—that will stand up in service—give it to us at a price we can afford to pay — and we will build equipment lighter."

So we produced COR-TEN.

—*almost twice as strong as ordinary steel*

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—*with superior fatigue resistance*

—*high in abrasion resistance*

—*a steel you can fabricate with little change in shop practice*

—***a steel that has made it possible to build mobile equipment 20–50% lighter—just as strong, just as rugged as the heavy construction it replaces.***

And now, the one obstacle to COR-TEN's general use has been removed. Today the cost per pound is so close to that of ordinary steel that in many applications COR-TEN actually costs less per unit of strength than plain steel.

Thus COR-TEN meets all the requirements set up for the ideal material for lightweight construction—it has great strength, superior endurance and stamina, unusually high corrosion resistance. Its cost is reasonable. So why not build lighter with COR-TEN? Why not get rid of excess weight that costs you money every time you move it?

Find out how little it costs to apply COR-TEN in your equipment. Our records of its use in thousands of lightweight freight cars, in high-speed passenger equipment, in the new streamlined trolleys, in trucks and buses, tractors and trailers, in steam shovels, cement mixers and mine skips, in mobile equipment of all kinds, are available to guide you in its economical application.

U·S·S HIGH TENSILE STEELS

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
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COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

Men Available

Engineering Societies Employment Service

JUNIOR M. E. Experienced in production planning of sheet-metal products, including cost estimating, routing, computing machine hours, setting of rate of production; desires connection with progressive concern. Has drafting experience. Will go anywhere. Me-1.

SALES ENGINEER. Graduate Stevens, M. E., 1911; heating and ventilating, power-plant and pump-sales experience. Me-2.

INDUSTRIAL ENGINEER, 48; has had experience in making industrial surveys and investigations; plant organization; manufacturing; accounting and cost experience. Me-3.

STRUCTURAL ENGINEER, graduate M. E., with structural design, construction, and appraisal experience. Me-4.

PURCHASING ENGINEER, graduate M. E., N. Y. State license, with experience in railroad, factories, machine shops, chemical industries, and power plants. Also export and machine-tool appraisal experience. Me-5.

PLANT ENGINEER. Graduate M. E., 1934; 30; planning and plant-layout experience; also safety and machinery-installation experience. Me-6.

COMBUSTION ENGINEER. Graduate M. E.; 44; fuel expert; real estate and building maintenance; N. Y. State license. Me-7.

MECHANICAL ENGINEER; 54; attended Columbia University, 3 years; Mass. Inst. of Technology, 1 year; experienced on drafting work, inspection, plant layout, power plant, heating and ventilating, and valuation. Available. Me-8.

GRADUATE MECHANICAL ENGINEER; 24; 14 months marine steam-power-plant operation and maintenance; 6 months in machine design; 4 months as machinist. Desires work in power-plant field. Location preferred, East. Me-9.

MECHANICAL DESIGNER, CHECKER; technical graduate, with machine-shop experience; 15 years' experience design and development of instruments and tools for aircraft, radio recording, and indicating thermometers and gages. Me-10.

MAINTENANCE AND POWER-PLANT ENGINEER; graduate mechanical engineer with 12 years' experience in maintenance and power-plant work. Power-plant tests, water treatment, cost investigation, pressure-vessel design. Available immediately. Me-11.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

CROUCH, CALVIN H., July 13, 1937
GULICK, HENRY, October 28, 1937
HICKS, GEORGE C., JR., January 17, 1937
JOHNSON, FRED V., December 3, 1937
MERSEREAU, THEODORE T., December 9, 1937
MITCHELL, ALBERT E., December 26, 1937
VAN DONGEN, D. W., November 24, 1937
WADSWORTH, GEORGE R., November 1, 1937
WINTZER, RUDOLPH, December 16, 1937

Candidates for Membership in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after February 25, 1938, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

NEW APPLICATIONS

ARNOW, SAMUEL M., Philadelphia, Pa. (Rt & T)
BEESE, PROF. C. W., Lafayette, Ind. (Rt)
BELAEF, NIKOLAI, Boston, Mass.
BRUNOT, A. W., Schenectady, N. Y.
BRYANT, WALTER A., Hartford, Conn. (Rt)
CHATEL, FRED J., Detroit, Mich. (Re)
CHEASLEY, THOS. C., Kansas City, Mo.
CLARK, V. O., San Francisco, Calif. (Rt)
CROCKER, JOHN W., Whitney, S. C.
EDWARDS, LAWRENCE V., Houston, Tex. (Re)
FORBES, F. P., Newark, N. J.
GROSSER, CHRISTIAN E., Waterbury, Conn.
HOWELL, E. L., Houston, Tex.
IACOBUCCI, ANTHONY J., Brooklyn, N. Y.
JARDINE, T. S., Toronto, Ont., Canada
KOESTER, CARL J., Fostoria, Ohio
KRAMER, ELTON P., Atlanta, Ga.
LEGGETT, I. W., Charlotte, N. C.
LEWIS, B. C , Chicago, Ill.
MAGOS, JOHN P., Chicago, Ill. (Rt & T)
MARCO, S. M., Columbus, Ohio
MESSENGER, J. A., New York, N. Y.
NETTLETON, GEO. H., 3d, New York, N. Y. (Rt)
OTTO, CARL A., Milwaukee, Wis.
PERT, D. M., Brooklyn, N. Y.
PIATT, CHAS. R., Plymouth, Pa.
PORTER, BURKE EARLE, East Grand Rapids, Mich.
PRINCE, WILLIAM, Hasbrouck Heights, N. J.
REA, THATCHER W., Detroit, Mich.
ROGERS, RALPH L., JR., Kingsport, Tenn.
ROSBOROUGH, J. G., Jr., St. Louis, Mo. (Rt)
SCHAEFFER, EMILE J., Chicago, Ill.
SHERMAN, PAUL F., Battle Creek, Mich.
SHIPMAN, L. A., Knoxville, Tenn.
STOCKING, R. PRESTON, Drexel Hill, Pa.
TARASKY, NICHOLAS, New Haven, Conn.
THOMAS, WILEY W., JR., Knoxville, Tenn.
VANDER VELDE, MARTIN H., Chicago, Ill.
VANDE VEN, ALVIN W., Oak Park, Ill. (Re)
WATT, D. G., Toronto, Ontario, Canada
WEYHER, T. A., Aberdeen, Md.
WILLIAMS, HARRY C., Syracuse, N. Y.
WINKLER, FRED'K H., New York, N. Y.
WINKLER, THEO. E., Detroit, Mich.

CHANGE OF GRADING

Transfers from Member

BATT, W. L., Philadelphia, Pa.
HERSEY, MAYO D., Philadelphia, Pa.
JACKSON, DUGALD C., Cambridge, Mass.
KERR, H. J., Westfield, N. J.

Transfers from Junior

CALNAN, E. J., St. Catharines, Ontario, Canada
DICKEY, DONALD E., Kirkwood, Mo.
HARRINGTON, R. P., Brooklyn, N. Y.
HAZARD, GEOFFREY C., St. Louis, Mo.
PACKHAM, E. THORNTON, Baltimore, Md.
UICKER, JOHN J., State College, Pa.
WAGNER, HARVEY A., Dearborn, Mich.

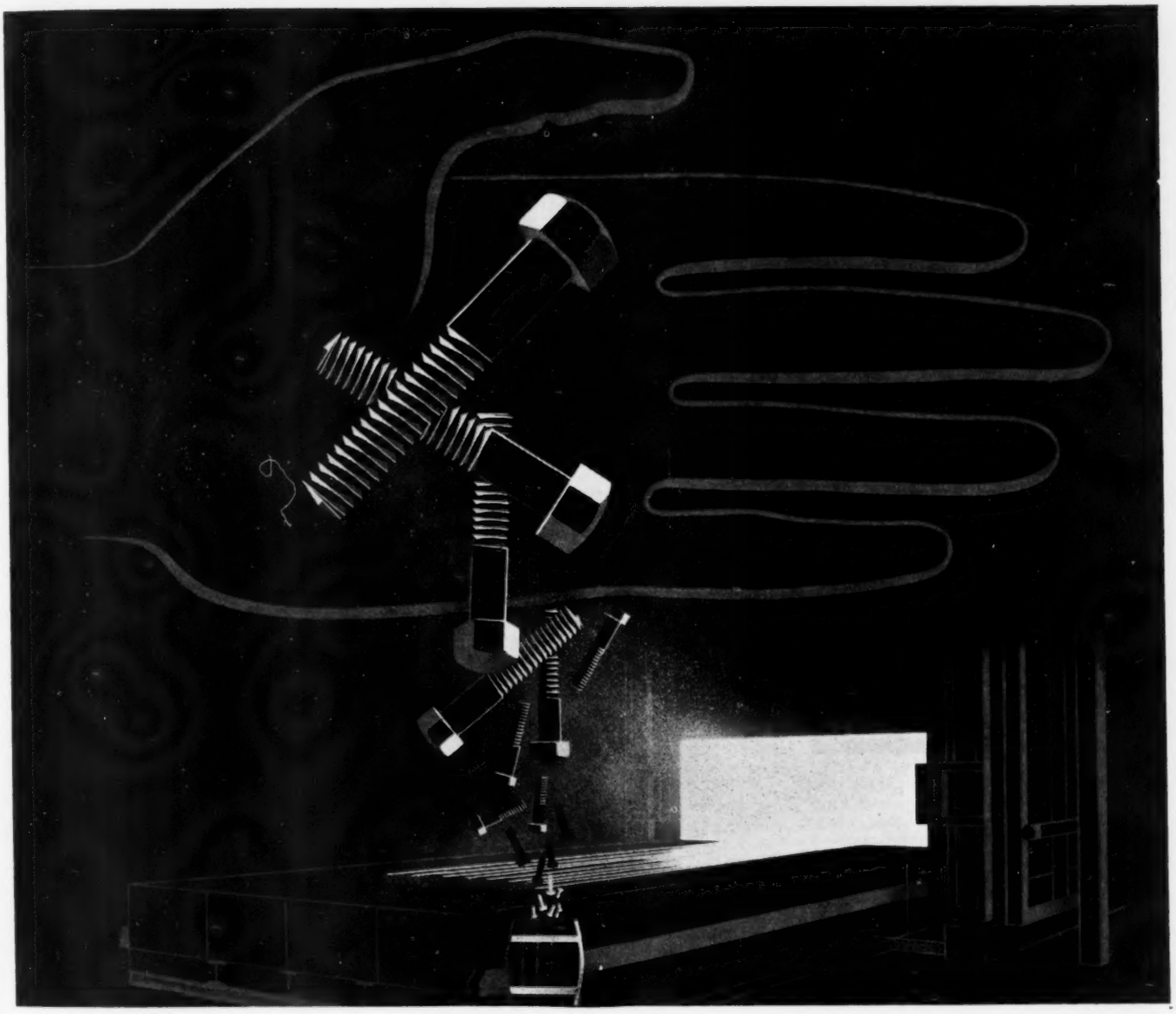
A.S.M.E. Transactions for January, 1938

THE January, 1938, issue of the Transactions of the A.S.M.E., contains the following papers:

Chain- or Traveling-Grate Stokers (FSP-60-1), by Gosta Anbro
Small Underfeed Single-Retort Stokers (FSP-60-2), by B. M. Guthrie
Selection of Coal for Pulverized Firing (FSP-60-3), by B. E. Tate
Underfeed Stokers From the Standpoint of Coal Selection (FSP-60-4), by J. E. Tobey
Burning of Waste Liquors in the Kraft and Soda-Paper Industries (FSP-60-5), by L. S. Wilcoxson
Protecting Steel Against Intercrystalline Attack in Aqueous Solution (RP-60-1), by W. C. Schroeder, A. A. Berk, and R. A. O'Brien
Relation of Wahl Correction Factor to Fatigue Tests on Helical Compression Springs (RP-60-2), by F. P. Zimmerli
Experiments in the Planing of Hardwoods (WDI-60-1), by E. M. Davis
Effects of Speed and Pressure on Cutting Rate of Coated Abrasive Products (WDI-60-2), by E. T. Hager
Hot-Pressing Technique for Plywood (WDI-60-3), by T. D. Perry and M. F. Bretl
European Progress in Hot-Press Bonding of Plywood in the Last Ten Years (WDI-60-4), by L. M. C. Wegner

DISCUSSION

On previously published papers by Messrs. T. V. Buckwalter, O. J. Horger, and W. C. Sanders; G. B. Karelitz and J. N. Kenyon; T. F. Olt; C. J. Starr; W. H. Stueve; and G. F. Jenks



LIKE PEAS FROM A POD

STEEL of uniform properties is the first key to a uniform product and to steady, economical production.

By using Chrome-Moly steel (SAE 4140), a manufacturer was able to heat treat 1/2" to 2" bolt stock in tonnage lots and still hold physical properties to close and difficult specifications. What's more, the steel was machinable enough after heat treatment to allow thread-cutting with a standard automatic die-head.

Uniform response to heat treatment is but one of the many qualities of Moly steels that help to simplify production problems.

Any engineering or production head interested in turning out a better product at lower cost will do well to look deeply into Moly steels and irons. Our technical book, "Molybdenum," is free for the asking. Climax Molybdenum Co., 500 Fifth Ave., New York.

PRODUCERS OF FERRO-MOLYBDENUM, CALCIUM MOLYBDATE AND MOLYBDENUM TRIOXIDE

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MOLY

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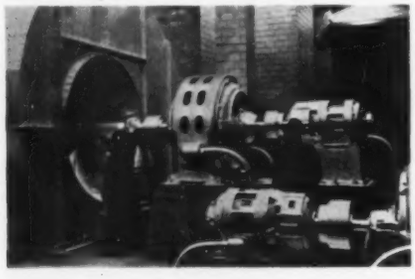
Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as the source.

Announcements from advertisers in MECHANICAL ENGINEERING and the MECHANICAL CATALOG

• NEW EQUIPMENT

Ventilating the Lincoln Tunnel

The Lincoln Tunnel connecting Up-town New York with New Jersey was officially dedicated and opened to vehicular traffic on December twenty-first. This event was celebrated by a record turn-out of big-wigs including Governor Lehman, Governor Hoffman, Mayor La Guardia, Secretary Ickes and Postmaster General Farley.



Part of the celebration was a parade thru the tunnel consisting of one hundred Fifth Avenue type busses carrying the guests, army trucks, tanks and fire apparatus—a slow moving procession that more than filled the entire 8000 foot tube. It was a severe christening for the ventilating equipment consisting of thirty-six large double width Buffalo fans handling about 3,500,000 cubic feet of air per minute. These fans were made by Buffalo Forge Co., 148 Mortimer St., Buffalo, N. Y.

Many favorable comments were heard about the ventilation. No trace of motor exhaust fumes was noticed. The lack of any haze in the atmosphere was particularly appreciated. The illustration shows one of the "Buffalo" Limit-Load Fans.

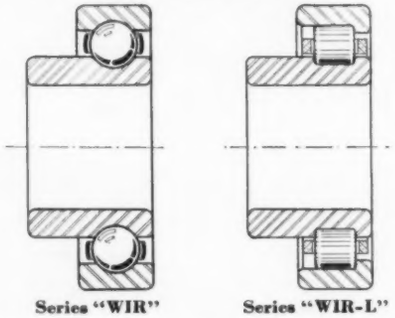
Farrel Hydraulic Metal Forming Press

The press illustrated was built by Farrel - Birmingham Company, Inc., Main & State Sts., Ansonia, Conn., for forming, blanking and drawing of metal. The press is the self-contained, individually-powered type, with the motor-driven pump mounted on top of the press. The capacity of the press may be varied between 50 and 300 tons. The press has one 18″ main ram and two double-acting rams, mounted in the top crosshead. The maximum working pressure is 2500 lbs. per square inch supplied by a radial piston pump driven by a 20 H.P. motor. The speed of the down-stroke is 241″ per minute, the return traverse 321″ per minute, and the pressing speed 12.7″ per minute. The press has a maximum opening of 44″ and a maximum stroke of 18″.

The crossheads and the frames between the top and bottom crossheads are made of Meehanite metal, a high strength, high tensile alloy iron. The tie rods are steel. The main cylinder is bronze lined. The moving crosshead is equipped with a specially adjustable knock-out. Ready adjustment of the moving crosshead guides is made possible by adjustable bronze gibs sliding against the finished interior surfaces of the press side frames.

Control of normal movements of the press is effected by a foot pedal located at the operator's left. Constant depression of this pedal causes the moving crosshead to approach the work, engage the work at the preset pressure and return, to again repeat the cycle. If the operator removes his foot from the pedal, the crosshead movement immediately stops. For die-spotting, a hand-lever is provided at the face of the left side frame, which causes slow movement or "inching" of the moving crosshead.

New Norma-Hoffmann Ball and Roller Bearings



Series "WIR" Series "WIR-L"

Norma-Hoffmann Bearings Corporation, Stamford, Conn., are now supplying two new types of Precision Bearings—the WIR Series of Ball Bearings and the WIR-L Series of Roller Bearings—as shown in the illustrations herewith. The distinctive feature of these new series is the use of a wide inner ring of double-row bearing width, in combination with an outer ring of single-row width. They have been designed primarily for opposed mounting in electric motors and similar equipment. The wide inner ring insures a better sealing on the shaft than the standard single-row ring. In many cases also it avoids the necessity for threading the shaft and applying lock nuts or other locking devices. This elimination of threads permits a larger shaft extension diameter for a given bearing bore and also avoids weakening of the shaft by threading. The WIR Ball Bearings are available in the medium metric series, from 25 to 55 m/m bore. The WIR-L Cylindrical Roller Bearings with one-lipped outer ring are available in the medium metric series, from 30 to 130 m/m bore.

New Fibrous Glass Has High Thermal Efficiency as Filler Insulation for Underground Steam Lines

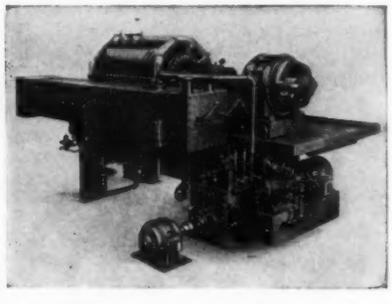
A new application for fibrous glass manufactured by the Corning Glass Works has been developed by the American District Steam Company, North Tonawanda, N. Y., for the insulation of underground steam lines. Known as ADSCO-Corning Filler Insulation, it is composed of long, flexible fibres of true glass in a soft resilient mass resembling cotton batting but possessing the permanence and chemical characteristics inherent in glass.

It has been proven by tests to possess a high thermal insulation efficiency with a very low conductivity rate of 0.33 at 4 lbs. density. It fluffs under vibration instead of packing, settling or disintegrating under such conditions. It is fireproof and unaffected by water, acids or fumes. It is exceptionally light in weight, being from $1/2$ to $1/4$ the weight of other types of insulating materials. It will not corrode pipes when dry or in the presence of water. It will not compress when thoroughly saturated with water and when dried out, it retains its original form without expansion.

It is packed in strong paper bags at a density which is suitable for maintaining a thermal insulation efficiency for pipe lines operating at a mean temperature of 650°F or it can be supplied for higher temperatures where required.

ADSCO-Corning Filler Insulation is illustrated and described in Bulletin No. 35-67 which is available by addressing the American District Steam Company, North Tonawanda, N. Y.

Centrifugal Water Vapor Refrigeration



The development, perfection, and advantages of the Centrifugal type of Water-Vapor Refrigeration as well as typical installations are presented in a new 32 page booklet issued by Ingersoll-Rand. Using water as the only refrigerant and providing operating characteristics such as sustained capacity, self regulation and high reserve capacity, these refrigerating units are the last word in cooling water for air conditioning and a variety of applications in industrial and chemical plants.

Centrifugal Water-Vapor Refrigerating Units can be driven by electric motor or steam turbine to economically meet any condition. Standard dimensions, as well as illustrations of diversified typical applications, are shown in this bulletin, number 9144, copies of which may be obtained from Ingersoll-Rand Company, 11 Broadway, New York. N. Y., or any of their branch offices.

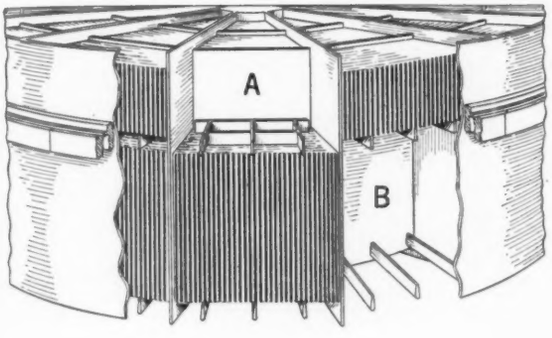
Announcing Bakelite Polystyrene Low Loss Molding Material

After several years of exhaustive research in its research and development laboratories, Bakelite Corporation, 247 Park Ave., New York, N.Y., announces a superior thermoplastic material for low loss purposes . . . Bakelite polystyrene molding material (XMS-10023)

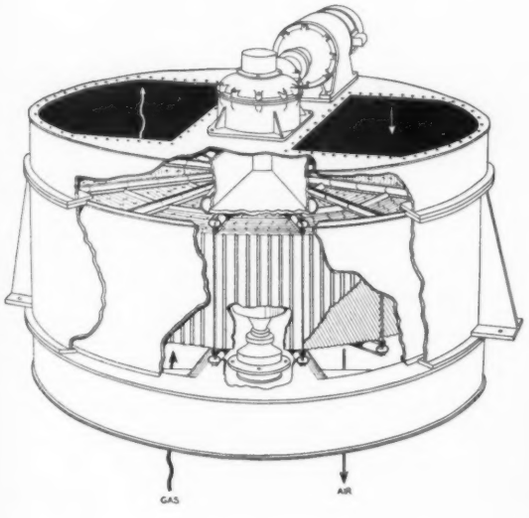
Continued on Page 18

AIR PREHEATERS

Maximum Heat Transfer, *with*
Minimum Maintenance Cost



Top view shows portion of Ljungstrom rotor with divided heating elements. The short top layer being removed from cell "A", and the longer bottom layer from cell "B". Lower view of Ljungstrom preheater is cut away to show elements and lower guide bearing.



The working parts of the Ljungstrom air preheater have been totally enclosed, simplified and reduced to the minimum.

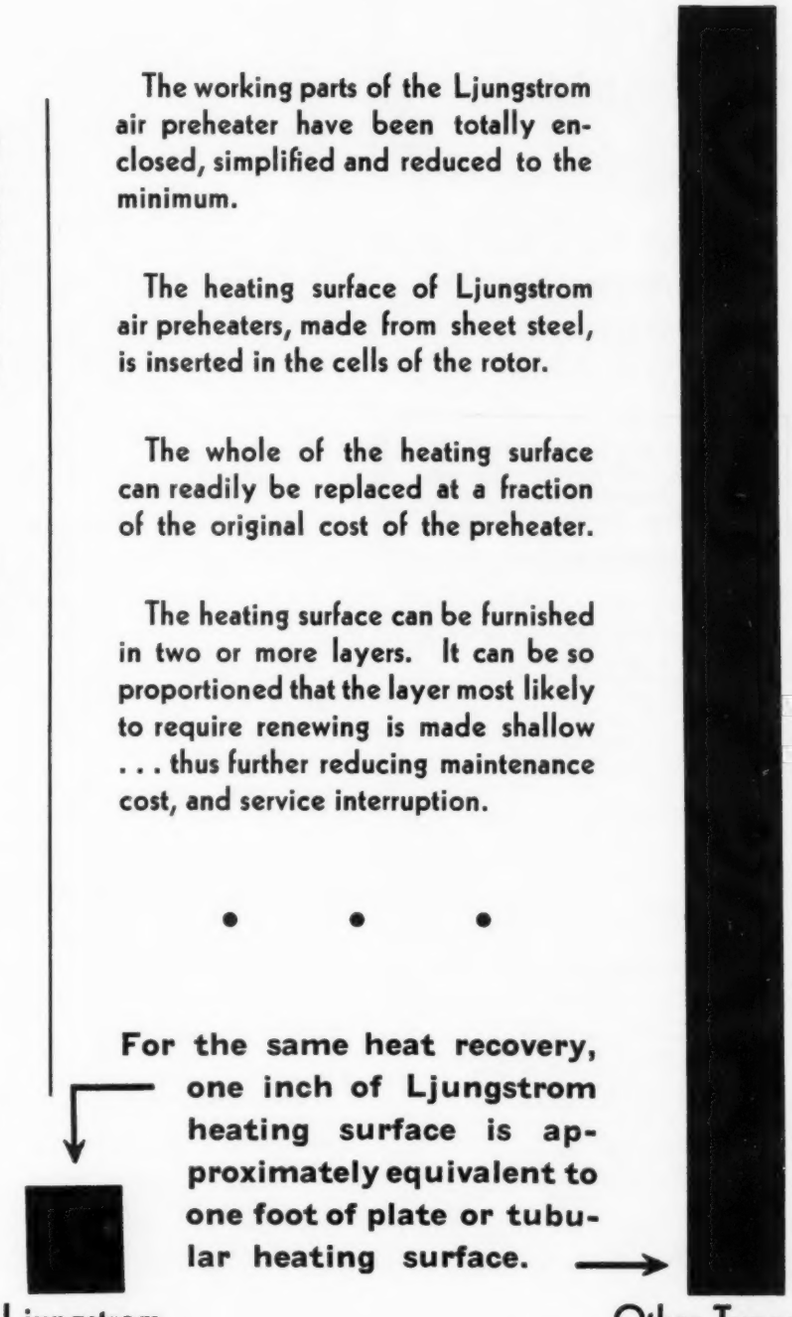
The heating surface of Ljungstrom air preheaters, made from sheet steel, is inserted in the cells of the rotor.

The whole of the heating surface can readily be replaced at a fraction of the original cost of the preheater.

The heating surface can be furnished in two or more layers. It can be so proportioned that the layer most likely to require renewing is made shallow . . . thus further reducing maintenance cost, and service interruption.

• • •

For the same heat recovery, one inch of Ljungstrom heating surface is approximately equivalent to one foot of plate or tubular heating surface.



Ljungstrom

Other Types

THE AIR PREHEATER CORPORATION

Under Management of THE SUPERHEATER CO.

60 East 42nd Street New York, N. Y.

A—1118

Preview!

ENGINEERING AND INDUSTRIAL STANDARDS

Notes on the Development of American Standards

to be published by the A.S.M.E.

The 1937 Annual Report of the A.S.M.E. Technical Committees is available to interested executives. Do you wish a copy?

PUNCH PRESS TOOLS

The standardization of punch and die sets used in the operation of punch presses has been in progress since 1928. Several drafts of the proposed standard have been distributed for criticism and comment. A further revised draft is expected from Technical Committee No. 9 of B5 shortly.

PLAIN WASHERS

For a number of years the standardization of plain washers has been in the hands of Sectional Committee No. B27. The final draft standard has been distributed to the members of the committee for review and vote. A canvass of this vote has been made and the committee is endeavoring to adjust the differences of opinion thus indicated.

CONVEYORS and CONVEYING MACHINERY

Good progress was made during the week of December 6–10, 1937 toward the organization of the five subcommittees which will develop the initial drafts of the several chapters of the proposed new American Standard Safety Code for Conveyors and Conveying Machinery.

• Keep Informed . . .

Continued from page 16

Bakelite polystyrene possesses a loss factor of less than .00053, a power factor of less than .0002, and a dielectric constant of 2.60 at 60 cycles, 1000 cycles and 1,000,000 cycles. This new Bakelite molding material offers marked advantages for many electrical products and equipment parts. Its dielectric strength is more than 500 volts per mil; its resistivity 10^8 megohm-centimeters; and its arc resistance 240–250 seconds. Tests indicate that no noticeable change occurs in electrical properties with an increase in temperature or humidity.

In addition to these electrical advantages Bakelite polystyrene molding material provides the important merits of: uniformity in molding; freedom from crazing or surface difficulties; permanence of dimension; and high resistance to water, acids and alkalies. Its durability and toughness are indicated by its A.S.T.M. impact strength of .16 to .20 foot pounds; flexural strength of more than 7000 pounds per square inch; and tensile strength of 5000 to 5500 pounds per square inch.

Opportunities for the improvement of high frequency apparatus and equipment through application of this new type of Bakelite molded are many. Following are specific electrical properties of the material:

Cycles Per Second	Power Factor
60 cycles	.0001 to .0002
1000 cycles	.0001 to .0002
1,000,000 cycles	Less than .0002

Dielectric Constant	Loss Factor
2.60	.00026 to .00053
2.60	.00026 to .00053
2.60	Less than .00053

Dielectric Strength 1/8"—Step Method—500 to 525 volts per mil

Volume Resistivity—Over 10^8 megohm-centimeters

Arc Resistance (Proposed A.S.T.M. Method)—240 to 250 seconds

New General Electric Portable Welder Is Gasoline-Engine Driven

A new, single-operator, portable welder, combining the improved Type WD-32B General Electric arc-welding generator and a standard 60-horsepower Ford V-8 engine, has been developed by the General Electric Company, Schenectady, N. Y., so that successful arc welding can be done independently of electric-power-line service. Designated as Type WD-32BY, the new welder has a NEMA rating of 200 amperes, 40 volt arc, 1 hour, 50 C, 60 to 200 amperes welding range. The complete unit, 24 inches wide, 60 inches long, and 43 inches high, can be loaded crosswise into practically any truck body. Net weight is approximately 1250 pounds.

Features of the welder include self-excitation, duplex control, and self-stabilization. The heavy commutator on the generator furnishes reliable excitation without the use of any external exciter parts. Duplex control gives the choice of current and voltage adjustments that is essential to the best work under many varying conditions. The self-stabilization characteristic of the Type WD generator permits easy welding with any type of wire, either bare or shielded arc, and with any current or voltage adjustment.

Standard parts are used in both engine and generator, and ready accessibility makes maintenance easy. Ample power is provided by the engine even at the conservative operating speed of 1750 rpm—equivalent to a car speed of 31 miles per hour. Less than two gallons of fuel per hour will operate the machine at full load. Standard sets include electric self-starter, battery charging generator, oil-bath air cleaner, fuel pump, ten gallon fuel tank, and vacuum speed governor. Optional features available at additional cost include electric slow-down control, crank case oil filter, waterproof tarpaulin, auxiliary 1 or 2 kw 125 volt d-c generator, and a two-wheel pneumatic-tired, roller bearing running gear with trailer hitch.

A special design of coupling, particularly compact and durable, is used to connect the engine crankshaft to the generator. Torsional shock is decreased by this type of coupling and bearing strain is minimized.

Taylor Fulscope Micromax Controller

For those process control problems where smooth, proportional valve action is imperative and the potentiometer principle of temperature measurement is preferred, the Taylor Instrument Companies, Rochester, N. Y., now offer the Fulscope Micromax Air-operated Potentiometer Controller. It utilizes the same completely adjustable, air-operated control mechanism that is used in the thousands of Fulscope temperature, pressure, rate of flow, and liquid level controllers now in service.

The temperature measuring system is the well known Micromax recording and indicating potentiometer. This is the only potentiometer in which all functions affecting accuracy of temperature measurement are fully automatic—automatic reference-junction compensation; automatic, positive balancing of the potentiometer circuit; and automatic current standardization. The principal parts of both mechanisms are interchangeable with the many Fulscope and Micromax instruments now in service. This permits small stocks of replacement parts, lower maintenance costs, and better service.

The Fulscope Control Unit operates in conjunction with the Taylor Motosteel Diaphragm Valve. Where precision valve action, or both precision valve action and compensation for changes in load, may be necessary to prevent deviation from the control point, the Fulscope control mechanism can be supplemented with the Taylor Valv-Precisor or Dubl-Response Control Unit, respectively. Thus, control equipment which most economically solves the individual control problem may be selected.

Write for Taylor Catalog 101R.

Fast Mine Hoist to Be Driven by G-E Equipment

General Electric is building electric equipment for the largest and probably the fastest a-c mine hoist in America. It will be installed at the Wenonah No. 9 mine of the Tennessee Coal, Iron & Railroad Company.

More than 6000 feet of wire rope will be wound around the 18-foot drum in hoisting the unbalanced load of 50,800 pounds. This enormous load will travel up the steep slope at a speed of 3600 feet per minute, or approximately 41 miles an hour. Only ten seconds will be consumed in loading or unloading the car.

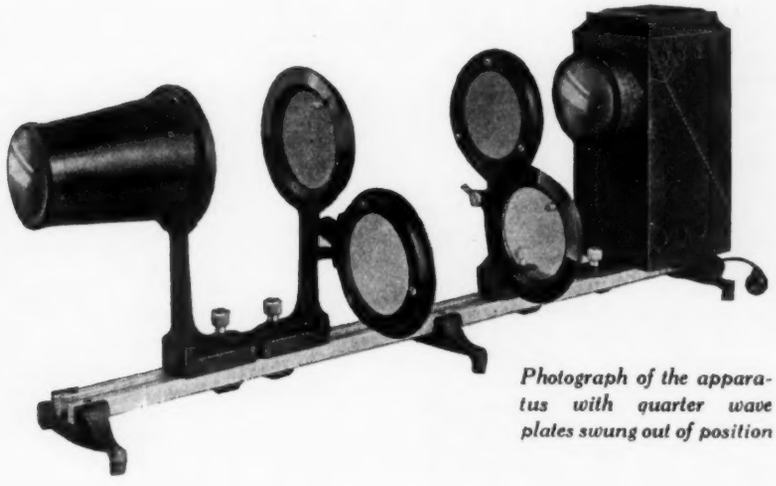
The G-E hoist motor is rated 2500 hp, and the control is reversible, full magnetic

Continued on Page 20

Polaroid — *for Stress Determination*

with LARGE Aperture PHOTOELASTIC POLARISCOPE

Angle Plate under Stress



Photograph of the apparatus with quarter wave plates swung out of position

The illustration shows an instrument of $4^1/_4$ aperture mounted on an optical bench one meter long. The four units are:

The Light Source, consisting of illuminant, filter for 5461 Å (with mercury light), condenser and collimating lens, within a single compact unit.

The Polarizer and quarter wave plate mounted in unit on a single rider but calibrated and rotated independently of each other.

The Analyzer and quarter wave plate similar to Polarizer.

The Projection system.

The polarizer and analyzer are set in rotating mounts with scale reading for 180°; the quarter wave plates are in rotating mounts with scale reading for 90°.

By this unique arrangement, this new model with its simplified construction facilitates photoelastic investigation. For taking the isoclinics, the quarter wave plates are merely swung out of position; for photographing the stress fringes, the quarter wave plates are swung back into position and automatically, into correct optical alignment. At all times, every part of the set-up is fixed in correct optical alignment.

The simplicity of the instrument is accentuated by the fact that there are no lenses in any position between the polarizer and the analyzer, eliminating inaccuracies caused by strained lenses, or depolarization which occurs at the edges of lenses.

The $4^1/_4$" aperture with "white" light source is priced at $300.00

DON'T GUESS AT AREAS OF STRESS CONCENTRATION! *See them visually.* DON'T GUESS AT AMOUNT OF STRESS! *Measure it quantitatively.* Axial loads do not always cause uniform stress distribution. The dimensions of a part are not necessarily an indication of its strength. Testing machine parts to the point of breakdown and thus approximating stress data can lead to conclusions which are at considerable variance from actual conditions.

The importance of photoelasticity for stress determination has been known for some time but in many cases, use has not been made of it because of the many objections to the Nicol prism arrangement to which one was limited prior to the development of Polaroid. In contrast to the complex apparatus heretofore used is the Polaroid-equipped photoelastic polariscope which is simple in construction, convenient for use and much lower in cost.

The change in design has been made possible only by the development of large area polarizing media and large area quarter wave plates. Standard sizes are available in apertures of $4^1/_4$", $6^1/_4$", and $8^1/_4$"; special sizes can be had up to 12" aperture. The light source may be ordinary light or mercury light (fitted with filter for 5461 Å). And for those who wish to construct their own apparatus, we will furnish any of the parts.

POLARIZING INSTRUMENT COMPANY

8 WEST 40th STREET, NEW YORK, N. Y.

• Keep Informed . . .

Continued from page 18

Dynamic braking will be used to reduce the speed when men are being hoisted. The resistor alone will weigh approximately 30,000 pounds.

The Tennessee Coal, Iron & Railroad Company has also had in operation for a number of years three similar hoist equipments, which operate at a rope speed of 2700 feet per minute. These also are driven by G-E motors.

Wade Print and Map Binder Hangers

Sturdy hangers that make a neat system for handling and filing all drawings and reference prints in the drafting room, plant or field are made by the Wade Instrument Company, Drawing Supply Manufacturers, 2246 ME Brooklyn Station, Cleveland, Ohio. Protect prints, tracings, drawings, maps and will hold up to 75 prints or 80 lbs. of paper. No holes to punch in prints—one turn with coin releases clamp. Made of

strong duralumin, with all edges rounded and with no sharp projections or screws that can mar or puncture other prints in the file or on the hanger itself. Very easy to grasp. The back view shows how the steel center hook turns down so that prints can be turned back for reference or rolled for transportation.

Just a turn with a coin (cent or quarter) releases prints. Insertion or removal of one or all prints is only a matter of seconds. The unique clamp arrangement holds the paper securely without damage. Sheets of different sizes may be clamped together.

The full length renewable title strip of 100% rag bristol is under thick non-inflammable Lumarith, and may be lettered to suit. All parts are rust-proofed and are very durable.

The overhanging lip at back, permits hanging on right angle wall hooks that point inward. With this system the center hook can be removed, and 6 or 8 hangers placed on a wall in tiers, each set being tucked back of those below. Two hooks at the end of each drafting table will hold a reference binder. Send for folder No. 18.

• BUSINESS CHANGES

Joseph A. Messenger Appointed Buell General Manager

Announcement was recently made of the appointment of Joseph A. Messenger, formerly of United Engineers & Constructors Inc., as general manager of the Buell Engineering Company, Inc., 70 Pine Street, New York, N. Y.

Mr. Messenger, well known in utility construction circles, became associated with the Construction Department of The United Gas Improvement Company on June 26, 1910. He supervised the construction of gas apparatus, both coal and water gas; power plants and gas distribution systems. He became assistant to the vice-president in charge of engineering of The U. G. I. Contracting Company and when United Engineers & Constructors Inc. was formed, he was placed in charge of the pipe line construction department, which post he held until his recent appointment.

Mr. Messenger will now be located at the headquarters of Buell Engineering Company, 70 Pine Street, New York City. The Company, a subsidiary of the American Goldfields Development Company, is engaged in the manufacture of fly-ash eliminators, dust collecting systems and turbo dryers for all industries.

Superheater Co. Appointments

The Superheater Company, 60 East 42nd St., New York, N. Y., has announced the election of Messrs. Bard Browne and N. T. McKee to be vice-presidents.

George Campbell Made Manager of G-E Sales Office at Syracuse

George Campbell, manager of the Schenectady local sales office of the General Electric Company, assumed the added responsibilities of the management of the Syracuse office on January 1, according to an announcement by H. H. Barnes, Jr., commercial vice-president.

The combined Schenectady and Syracuse territories include all of New York state and Susquehanna, Bradford, and Tioga counties in Pennsylvania, except the metropolitan New York and Buffalo areas.

Mr. Campbell succeeded A. J. Hornsby in the Syracuse area, who retired on December 31 after 38 years of service with the Company. Mr. Campbell entered the testing department of General Electric in 1907, following his graduation from Brown University where he received the B.S. degree in electrical engineering. In 1909 he was transferred to the switchboard and lighting commercial departments and was then sent to the Charleston, W. Va., office for one year. He spent seven years in the Schenectady office, after which he was made resident agent at Niagara Falls. He was named manager of the Schenectady office in 1925.

Mr. Hornsby started work with the Company in 1899 after graduation from Union College. He entered the testing department, and upon completion of the course he was transferred to the lighting department. In 1905 he was sent to the Syracuse office of the Company and in 1912 was appointed manager.

• LATEST CATALOGS

The Control of Friction

An interesting bulletin on lubrication issued by the Fiske Bros. Refining Co., 129 Lockwood St., Newark, N. J. In it are given the characteristics of "Lubriplate" as well as its uses and applications.

New Nickel Alloy Bulletin

Three new bulletins have just been issued by The International Nickel Co., 67 Wall St., New York, N. Y., and are now available.

"Nickel Alloys for High and Low Temperature Refinery Service" treats briefly on the high and low nickel-chromium alloys having

Continued on Page 22

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RATE Announcements under this heading in MECHANICAL ENGINEERING are inserted at the flat rate of $1.25 a line per issue, $1.00 a line to A.S.M.E. members, Minimum charge, two line basis. Uniform style set-up. Copy must be in hand not later than the 10th of the month preceding date of publication.

Like a page from "WHO'S WHO" in Central Stat

CENTRAL STATIONS

WHICH HAVE INSTALLED

SMOOT COMBUSTION CONTROL

ACME STATION
Toledo Edison Co.,
Toledo, Ohio

COMAL STATION
San Antonio Public Service Co.,
New Braunfels, Texas

DEEPWATER STATION
Deepwater Operating Co.,
Penns Grove, N. J.

EAST RIVER STATION
New York Edison Co.,
New York, N. Y.

ENGLISH STATION
United Illuminating Co.,
New Haven, Conn.

FAR ROCKAWAY STATION
Queens Borough Gas & Elec. Co.,
Far Rockaway, N. Y.

★ **FISK ST. STATION**
Commonwealth Edison Co.,
Chicago, Ill.

★ **FT. COLLINS MUNICIPAL PLANT**
Ft. Collins, Colo.

GLENWOOD STATION
Long Island Lighting Co.,
Glenwood Landing, N. Y.

GORGAS STATION
Alabama Power Co.,
Gorgas, Ala.

GORGE STATION
Ohio Edison Co.,
Akron Ohio

★ **HAWAIIAN ELECTRIC CO.,**
Honolulu, Hawaii

HELL GATE STATION
New York Edison Co.,
New York, N. Y.

HUDSON AVE. STATION
Brooklyn Edison Co.,
Brooklyn, N. Y.

★ **HOLYOKE WATER POWER CO.**
Holyoke, Mass.

★ **HAVANA PLANT**
Cia Cubana de Electricidad,
Havana, Cuba

KEARNY STATION
Public Service Elec. & Gas Co.,
Kearny, N. J.

KENOVA STATION
Appalachian Elec. Power Co.,
Kenova, W. Va.

★ **KNIFE RIVER STATION**
North Dakota Power & Light Co.,
Beulah, N. D.

★ **LAFAYETTE ST. STATION**
Iowa Public Service Co.,
Waterloo, Iowa

LAUDERDALE STATION
Florida Power & Light Co.,
Ft. Lauderdale, Fla.

LOWELLVILLE STATION
Ohio Edison Co.,
Lowellville, Ohio

MOORE'S PARK STATION
City of Lansing, Mich.

★ **MUNICIPAL UTILITIES**
Marshall, Mo.

★ **MUNICIPAL POWER PLANT**
Rochester, Minn.

NARRAGANSETT STATION
Narragansett Electric Co.,
Providence, R. I.

NORTHPORT STATION
Long Island Lighting Co.,
Northport, L. I., N. Y.

SAGINAW RIVER PLANT
Consumers Power Co.,
Zilwaukee, Mich.

ST. JOHN PLANT
New Brunswick Power Co.,
St. John, N. B.

★ **SHELBY STATION**
Great Northern Utilities Co.,
Shelby, Mont.

SHERMAN CREEK STATION
New York Edison Co.,
New York, N. Y.

66TH ST. STATION
Brooklyn Edison Co., N. Y.

SPRING GARDENS STATION
Cons. Gas, Elec. Light & Power
Co., Baltimore, Md.

★ **STATE LINE STATION**
Chicago District Elec. Generating
Co., Hammond, Ind.

★ **STEEL POINT STATION**
United Illuminating Co.,
Bridgeport, Conn.

TORONTO STATION
Ohio Edison Co.,
Toledo, Ohio

WAUKEGAN STATION
Waukegan Generating Co.,
Waukegan, Ill.

★ **WEST END STATION**
Cincinnati Gas & Elec. Co.,
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Continued from page 20

good strength and "creep" resistance at elevated temperatures. It also mentions the suitability of the pearlitic type steels containing from 2 to 5% nickel, and the 18-8 type austenitic steels for low temperature service. On pages 2 and 3 appears an interesting flow chart indicating all the points at which nickel-containing alloys may be applied in oil refinery equipment.

The bulletin "High Strength Corrosion-Resisting Rivets for Marine Construction" points out the superior features of the low carbon 1½% nickel steel rivets as regards physical properties and driving characteristics and describes the superior corrosion resistance possessed by this material because of its lower galvanic potential, as compared with ordinary steel, when coupled with ship plate.

"Nickel Alloy Steels in Oil Well Tools" describes the numerous applications which the nickel, nickel-chromium, and nickel-chromium-molybdenum steels are findings in the oil fields for drill collars, kelly bars, fishing tools, slips, and similar parts where greater strength and ductility are required than can be obtained from unalloyed steels.

Brown Numeral Print Record Folder

The Brown Instrument Co., 4496 Wayne Ave., Philadelphia, Pa., has just published a new folder No. 84-9 entitled—"Legibility plus Precision."

This folder, printed in seven colors, reproduces the colored numeral records, exactly as they are printed on the chart of the Brown Potentiometer Pyrometer Recorders. It explains the significance of the Brown (+) Symbol, an exclusive feature, which is a part of each numeral record.

Instruments for Time Study

A. R. & J. E. Meylan, 268–70 West 40th Street, New York, N. Y., Specialists in Timing Instruments, have just issued a new 12 page folder showing some 40 types of Stopwatches. Each instrument is illustrated and fully described in detail. Included are the Meylan Stopwatch Stand and a new Time Study Board.

F-M Vertical Motors

Fairbanks-Morse vertical hollow and solid shaft polyphase, ball-bearing, squirrel-cage, induction motors are described in new bulletin 1410 just issued by Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill. Although these motors were developed primarily for direct-connection to vertical-shaft turbine, propeller and centrifugal type pumps, they have found wide application on special machine tools and various other industrial equipment.

Hollow shaft vertical motors are particularly adapted to turbine pump application because of the ease of installation, assured permanent shaft alignment, weather-proof construction, high thrust capacity and compact design. The upper motor bearing supports the entire load on the pump shaft, including weight of shafting and rotating parts of pump, as well as the thrust load of the column of liquid being lifted. The exterior design of the motor and its ventilating openings make the machine weather proof so that it can be operated in the open all year around without injury. Adequate ventilation is provided by sturdy fans at both ends of the rotor. Rain water or other liquids will not blow into the windings.

Vertical centrifugal pumps or turbine pumps with self-contained thrust bearings usually are driven by solid shaft motors through flexible couplings. In such installations, the motor bearings normally are designed to carry only the rotating parts of the motor. Solid shaft motors also are well suited for use with machine tools and other industrial equipment. They are supplied in a variety of electrical modifications such as line start, high torque, low slip, multi-speed, etc. to fit practically any industrial requirement.

Interchangeable Bearings

New Departure Division, General Motors Corp., Bristol, Conn., announces the publication of its new Booklet "Interchangeable Bearings." This publication contains numerically arranged lists of competitive ball bearings, together with the corresponding numbers of interchangeable New Departure bearings. In addition, space is devoted to alphabetically arranged definitions of letters and letter combinations used by various manufacturers to identify bearing characteristics.

Wade Drawing Supplies

New folder No. 18 just issued by the Wade Instrument Co., 2246 ME Brooklyn Station, Cleveland, Ohio, describes printed border and title block service, Waco Parchment, Vellum and drawing paper, in plain or printed sheets and rolls that will greatly interest draftsmen. Drafting curves, compass, Isometric and Perspective papers. Blue print Binder Hangers. Shop Envelopes.

James Double Worm Gear Reducers

Announcement is made by D. O. James Mfg. Co., 1120 West Monroe St., Chicago, Ill., that manufacture has just started of three new sizes of Double Type Worm Gear Reducers with large range of speed ratios from 30 to 3,600 to 1, having torque capacities at slow speed shaft from 40 inch pounds to 400 inch pounds.

This type reducer consists of two bronze worm gears and steel worms mounted on Timken Tapered Roller Bearings within a small space giving a light drive with high ratios. Bulletin on request.

New Lincoln Bulletin Aids Designer in Utilizing Welded Construction

"How to Change Over to Welded Design for Profits" is the title of a new 32-page profusely illustrated bulletin just published by The Lincoln Electric Co., Coit Road and Kirby Ave., Cleveland, Ohio. Intended as an aid in applying electric welding to the design of machines and machinery structures, the new bulletin sets forth the experiences of many manufacturers who have redesigned their products for arc welded construction.

Of particular interest are illustrations of products as they were formerly built by some other method and their modern arc welded counterparts. Their construction is clearly shown, together with a comparison of results obtained with the old method and the modern one. Many arc welded machine parts such as levers, wheels, brackets, frames, bases, containers and covers, which are common to practically every piece of machinery, are illustrated by photographs and line drawings. A study of these small parts and application of the method of welding them enables the designer to visualize larger and more complicated structures arc welded. The idea that every machine is an assembly of easily designed parts is the message carried to the designer. Changing the product from traditional methods of construction to arc welding is accomplished most simply by converting the component parts one at a time. This step-at-a-time procedure, according to the bulletin, will assure most satisfactory results and greatest economy from application of welding to product design.

Included in the bulletin are photographs of production executives of many leading industrial concerns which are manufacturing products of arc welded steel. Statements by these men are enthusiastic regarding the quality and economy of arc welded construction.

Tile Conduit

A revised, two color, 8 page Bulletin No. 35–67A on ADSCO-Bannon Tile Conduit and ADSCO-Corning Filler Insulation for underground steam or hot water lines, including illustrations of the products, details of construction and their applications, is available by addressing the American District Steam Company, North Tonawanda, N. Y.

Centrifugal Pumps

A bulletin on a unique type of centrifugal pump for handling large capacities at low heads has just been published by Morris Machine Works, Baldwinsville, N. Y. This unit, known as the Morris Straightflo Pumps, is a marked departure from standard designs of centrifugal pumps with volute shell and impeller. The specially formed casing and screw type propeller of this design enable the pump to handle refuse and sewage as well as clear water, with extremely high efficiencies when direct driven by standard high-speed motor, and the assembly is remarkably compact. The new bulletin describes these pumps in detail with exterior views, sectional drawings and dimensions of both horizontal and vertical types and with complete rating table showing the performance of the pumps from 10-in. to 24-in. sizes, for capacities above 1500 g.p.m. and for heads up to 40 ft.

COMING MEETINGS AND EXPOSITIONS

For the next three months

FEBRUARY

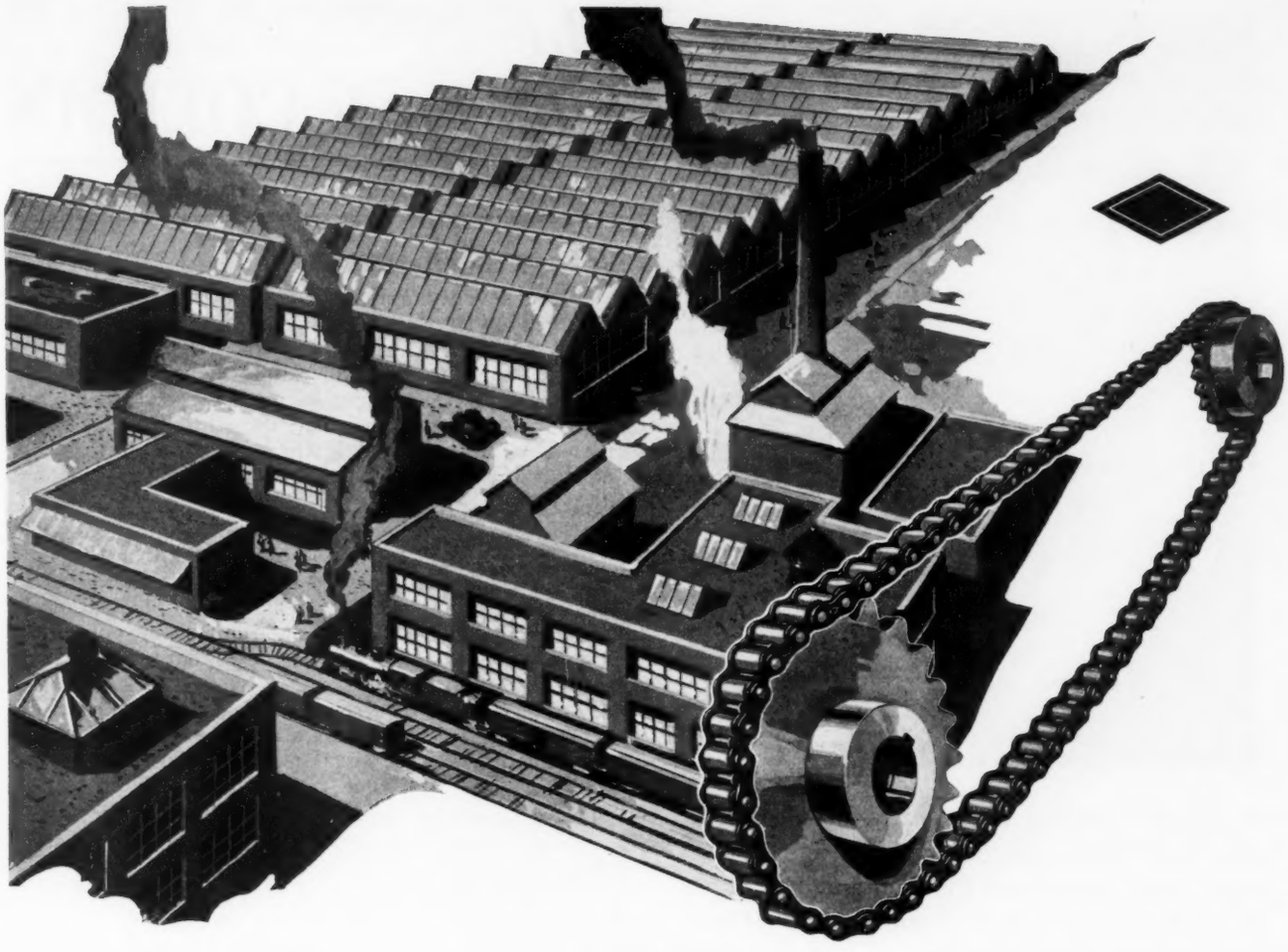
14–18	American Institute of Mining & Metallurgical Engineers, Annual Meeting, New York, N. Y.

MARCH

7–11	American Society for Testing Materials, Regional Meeting, Rochester, N. Y.
15–17	American Railway Engineering Association, Annual Meeting, Palmer House, Chicago, Ill.
Wk. of 21	American Society for Metals, Western Metal Congress, Los Angeles, Calif.
23–25	American Society of Mechanical Engineers, Spring Meeting, Los Angeles, Calif.
Wk. of 28	American Ceramic Society, Annual Meeting, Roosevelt Hotel, New Orleans, La.
28–30	Society of Automotive Engineers, National Passenger Car Meeting, Hotel Statler, Detroit, Mich.

APRIL

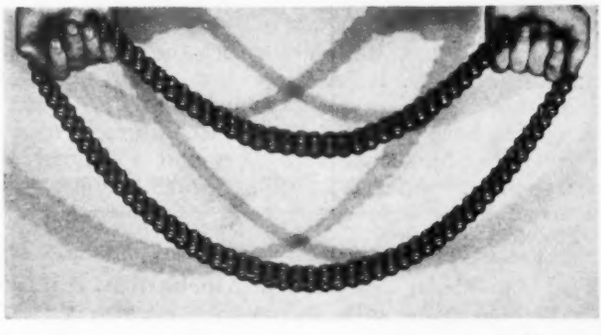
Wk. of 17	American Society of Civil Engineers, Spring Meeting, Jacksonville, Fla.
18-19-20	American Gear Manufacturers Association, 22nd Annual Meeting, General Brock Hotel, Niagara Falls, Canada.
Wk. of 24	American Water Works Association, Annual Convention, New Orleans, La.



From a Few – to 5729 Diamond Drives in the Plants of One Company

● Beginning with a few Diamond Roller Chain Drives 18 years ago—one manufacturer alone now has nearly six thousand of these drives in operation.

It is reasonable to assume that good proof of the high power transmitting efficiency,—long trouble-free life—maintained high production rates had much to do with the constant increase of the number of Diamond Drives installed.



You can obtain such proof too—a few Diamond Drives in your plant will give you actual records for comparison. You will benefit by the advantages mentioned above and through the elimination of bearing troubles and slipping,—as well as by reducing replacement and adjustment troubles.

Our latest 100-page catalog has been painstakingly prepared to make easy the selection of chains for any drive...Let us mail you a copy. DIAMOND CHAIN & MFG. CO., 413 Kentucky Ave., Indianapolis, Ind. *Offices and Distributors in Principal Cities.*

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• Design Engineers whose early installations of Cleveland Worm Gear Speed Reducers have been followed by long years of faithful and continuous performance, are constantly ordering *more* Clevelands—confident that such long terms of service will be repeated, even lengthened, during future years.

From its founding in 1912 until today, this Company has applied itself not only to building Worm Gearing *exclusively*, but to progressive improvement by concentrating through Research, Design and Engineering upon the manufacture of units distinguished for their constant, trouble-free performance, for low maintenance cost (or none at all) and extremely long life—20 years' continuous operation is nothing unusual.

Trustworthy Clevelands enhance the value of your own equipment to customers—establish good will—help you create repeat business. An experienced District Representative will gladly help you in applying Cleveland Drives correctly. The Cleveland Worm & Gear Company, 3264 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

CLEVELAND *Worm Gear Drives*

The Standards COLUMN

News of Interest to Manufacturers

Wrench-Head Bolts and Nuts

Of the seventy standards which the A.S.M.E. has sponsored under the procedure of the American Standards Association during the past twenty years, the standard for the cross-flat dimensions of hexagonal and square bolt heads and nuts and wrench openings is one of the most popular. The first edition of this standard was published in 1927, the second edition in 1933, and during these 10 years 10,000 copies have been sold.

A revision and extention of this standard is now in progress and should become available within the next six months. This will be the second revision or the third edition. In addition to the material presented in the 1933 edition the new edition will contain illustrations of the several types of bolt heads and nuts, some corrections to the original tables and footnotes, additional tables giving the standard dimensions of four types of slotted nuts, the addition of a series of seven definitions of important terms used in the industry, and an appendix consisting of a summary of the formulas for the tabulated dimensions and a table of bolt and thread lengths.

This standard is one of nine initiated and developed by the Sectional Committee on the Standardization of Bolt, Nut and Rivet Proportions (B18) of which Prof. Arthur E. Norton is chairman. It is the result of years of intensive study and analysis of the practices and the needs of industry by Subcommittee No. 2 organized in March, 1922, of which Commander T. D. Ruddock, Jr., is chairman and J. H. Edmonds vice chairman.

Early in its work Subcommittee No. 2 laid a firm foundation for its report by charting the cross-flats dimensions of all the known types and sizes of hexagonal and square bolt heads and nuts. Studies of these charts were made to determine the least number of wrench openings and the corresponding cross-flats dimensions which would adequately serve the demands of industry.

As an illustration of the careful way in which this subcommittee did its work and the broad publicity which was given to each step in the development of this American Standard, it might be stated that in December, 1923, twenty-one months after its organization, the committee issued a tentative report containing seven tables, four graphs, and two pages of explanatory material which was printed and distributed very extensively for criticism and comment. The first draft of the proposed American Standard appeared in December, 1924, the second in October, 1925, the third in October, 1926 and the first approved edition in February, 1927. During this period of drafting and redrafting a thorough study of the standards of foreign countries was also made.

The Sectional Committee on the Standardization of Bolt, Nut and Rivet Proportions (B18) is sponsored jointly by the Society of Automotive Engineers and The American Society of Mechanical Engineers. At present its membership consists of forty-nine (49) representatives of twenty-six (26) national organizations.

For further information—address

The American Society of Mechanical Engineers
29 West 39th St., New York, N. Y.